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CCTV surveillance systems for use in security applications —

Part 3: System design requirements

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Foreword

This Kenya Standard was developed by the Technical Committee on Extra-low Voltage and is in accordance with the procedures of the Bureau.

In the preparation of this Kenya Standard reference was made to SANS 10222-5-1-2:2007

Acknowledgement is hereby made for assistance derived from this source.

CCTV surveillance systems for use in security applications – Part 3: System design requirements

1 Scope

This part of Kenya standard gives recommendations for the general design requirements for CCTV surveillance systems used in security applications.

The objectives of this part of Kenya Standard are to
a) Provide an overview of typical CCTV equipment features and functions,
b) Assist in specifications and enable users in determining the appropriate equipment required for a given application
c) Provide guidance in the preparation of typical CCTV system design specifications.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of Kenya Standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this part of Kenya Standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the Kenya Bureau of Standards.

KS 2110-1- *Installation and remote monitoring of detector activated CCTV systems- code of practice*

KS 2110-2 – *CCTV surveillance systems for use in security applications – Operational requirements*.

KS 2110-4– *CCTV surveillance systems for use in security applications – Installation requirements*.

KS 2110-5– *CCTV surveillance systems for use in security applications – Testing, commissioning and handover requirements*.

KS 2110-6– *CCTV surveillance systems for use in security applications – Maintenance requirements*.

3 Definitions and abbreviations

For the purposes of this Kenya Standard, the following definitions and abbreviations apply:

3.1 Definitions

3.1.1
Aperture number of the lens *(f)*
The index of the theoretical light-gathering power of the lens, expressed as the ratio of the effective diameter of the lens (entrance pupil) to the focal length of the lens

3.1.2
Back focus
The distance between the external surface of the lens that is closest to the imaging device and the focal point of the lens

3.1.3
C & CS mount
Mounting format of various camera lenses

3.1.4
Camera housing
An enclosure to provide physical or environmental protection (or both) of the camera, lens and ancillary equipment

3.1.5
Camera sensitivity
Imaging device illumination necessary to produce a defined composite (colour) video signal amplitude with a defined signal-to-noise ratio

3.1.6
CCTV camera
A unit that contains an imaging device that produces a video signal from an optical image

3.1.7
CCTV camera equipment
A unit that contains a CCTV camera plus appropriate lenses and the necessary ancillary equipment

3.1.8
CCTV control unit
Equipment for controlling and monitoring the required operational functions of the CCTV system

3.1.9
CCTV surveillance installation
An installation consisting of the hardware and software components of a CCTV system, fully installed and operational for monitoring a defined security zone

3.1.10
CCTV surveillance system
A system that consists of camera equipment, monitoring and associated equipment for transmission and controlling purposes, which may be necessary for the surveillance of a defined security zone

3.1.11
Character generator
A device for generating alphanumeric characters or symbols (or both) and adding them into the image

3.1.12
Composite colour video signal
CCVS
The video output signal of a colour camera, which signal comprises the burst and colour information (colour), the picture component (video), black reference (blanking) and the synchronization components (synchronization)

3.1.13
Composite video signal
CVS
The video output signal of a black and white (b/w) CCTV camera comprising the picture component (video), black reference (blanking) and the synchronization components (synchronization)

3.1.14
Decibel
A measure of the voltage or power ratio of two signals; decibel gain or loss is 20 times log 10 of the voltage or current ratio, and 10 times log 10 of the power ratio

3.1.15
Electronic iris
An automatic electronic shutter that varies the CCTV camera sensitivity in relation to the varying light conditions in order to maintain the video output signal within defined limits

3.1.16
Electronic shutter
An arrangement in a CCTV camera for changing its sensitivity by electronically controlling its exposure time

3.1.17
Event recording
The event controlled recording or storing of image signals for a predetermined time

3.1.18
External synchronization
A method of feeding reference timing signals to all connected devices to ensure that their video output signals are synchronous

3.1.19
Focal length *(F)*
A property of a lens, expressed in millimeters, giving the angle of view for a given sensor size

3.1.20
Imaging device
A device that converts an optical image into an electrical signal

3.1.21
Imaging device illumination
The level of illumination (illuminance) at the photosensitive surface of the imaging device

3.1.22
Image sensor size
The size of the light sensitive surface of the imaging device

NOTE: The value is expressed in inches and refers to the diameter of the glass tube from which the camera tubes are constructed or, in the case of CCD cameras, the diagonal measurement of the sensor.

Some examples of sizes are:

- 1 inch for 12.8 × 9.6 mm (16 mm diagonal)
- 2/3inch for 8.8 × 6.6 mm (11 mm diagonal)
- ½ inch for 6.4 × 4.8 mm (8 mm diagonal)
- 1/3 inch for 4.8 × 3.6 mm (6 mm diagonal)

3.1.23
Iris
A variable-aperture mechanism that regulates the amount of light that passes through the lens onto the imaging device of the CCTV camera

3.1.24
Lens
An optical device for projecting an image of a desired scene onto the photosensitive surface of the imaging device

3.1.25
Pan-and-tilt camera unit
A motorized unit permitting the vertical and horizontal positioning of the camera equipment

3.1.26
Picture storage
The storing of video images

3.1.27
Preset shot
A function in pan-and-tilt camera units or zoom lenses (or both) that allows automatic return to one or more predetermined positions

3.1.28
Scene illumination
The level of illumination (illuminance) on the area to be kept under surveillance

3.1.29

Scene reflectance
The proportion of the scene illumination reflected by that scene

3.1.30
Slow-scan transmission
The transmission of a series of non-real-time images or part images by means of analogue or digital signals over limited-bandwidth transmission media

3.1.31
Time and date generator
A device for generating the time and date and incorporating them into the image

3.1.32
Time-lapse recording
the periodical recording of video signals at predefined intervals

3.1.33
Time multiplex recording
A method for recording several video signals on one video channel by time-multiplexing the frames of these video signals

3.1.34
Transmission number of lens (*T*)
The index of the actual light-gathering power of the lens

3.1.35
Variable focal length lens
A lens with variable focal length in which the image does not remain in focus as the focal length changes

3.1.36
Video equalizing amplifier
Equipment for correcting gain-related and frequency-related distortions in the video signal

3.1.37
Video matrix
A unit for connecting several input video signals to several outputs

3.1.38
Video monitor
A device for converting video signals into pictures on a display screen

3.1.39
Video printer
Equipment for converting a video signal into an image on paper

3.1.40
Video switcher
A unit for switching a number of video input signals to one or more outputs manually or automatically or on receipt of an external signal

3.1.41

Zoom lens

A lens with adjustable focal length, in which the image of the scene remains in focus as the focal length is changed

3.2 Abbreviations

3.2.1 CCD: Charge-coupled device

3.2.2 CCIR: Comité Consultatif International des Radio communication (International Radio Consultative Committee)

3.2.3 CCTV: closed-circuit television

3.2.4 dB: decibel

3.2.5 RF: radio frequency

3.2.6 SPD: surge protection device

3.2.7 UPS: uninterruptible power supply

3.2.8 VCR: video cassette recorder

3.2.9 VHS: video home system

4 The role of CCTV in security applications

In its broadest sense, the purpose of CCTV in a security application is for a security operator to create live-action displays from a distance. The CCTV system should also include a recording capability, either a VCR or other storage media, to maintain a permanent record of the displayed events for evidence purposes. The typical hardware components of a CCTV system will include four basic components, namely (a) camera(s), lens(es), monitor(s) and transmission link(s). In addition to these basic components, comprehensive CCTV systems would include one or more video switchers, multiplexers, matrix switchers, recorders, hard-copy printers and ancillary equipment. See annex A for the layout schematic of a typical large CCTV system.

Some applications for which CCTV provides an effective solution are

a) Overt visual observation of a scene or activity from a remote location,
b) Covert observation of a scene,

c) Recording of a scene when triggered by an alarm sensor,
d) Observation of many locations simultaneously from a central control point, and
e) Providing video evidence when a crime has been committed.

5 System design criteria

When designing a CCTV surveillance system installation, the following criteria should be taken into account, bearing in mind the need to meet the operational requirement:

a) Determination of the zones or objects that require surveillance;
b) Determination of the number of cameras, and their locations, required to monitor the agreed zones or objects;
c) Evaluation of existing lighting and consideration of new or additional illumination;
d) Selection of cameras and equipment, depending on the environmental operating conditions;
e) control-point configuration;

f) Power supplies;
g) Determination of functional and operating procedures; and
h) Maintenance.

The determination of the zones or objects to be covered by the CCTV system will be provided by the operational requirement document (see SABS 0222-5-1-1 or the equivalent Kenya Standard). All other aspects of the above-mentioned criteria should be considered by the designer of the complete CCTV system.

6. Equipment overview

NOTE: This clause provides an overview of the individual items of equipment that comprise a CCTV system with regard to fundamentals of operation and the terms used to specify operational performance.

6.1 Cameras

6.1.1 Specifications

At present there is no standard method for manufacturers to present data that define camera performance. Therefore, it is essential that manufacturers' specification literature be studied very carefully and that comparisons be made against a common standard before making a selection.

6.1.2 Fundamentals of operation

The function of the camera is to convert the visible scene formed by the lens into an electrical signal suitable for transmission to the monitor, recorder or printer. The camera consists of

a) An image sensor,
b) Some form of electrical scanning system with synchronization,
c) Timing electronics,
d) Video amplifying and process electronics, and
e) Video signal synchronizing and combining electronics to produce a composite video output signal.

6.1.3 Types of camera

6.1.3.1 General

Two basic types of cameras exist, namely cameras with tube-type sensors and cameras with solid-state sensors. Although tube-type cameras can still be found in some of the older types of CCTV security installations, solid-state cameras have now become the standard.

6.1.3.2 Tube cameras

The tube camera video signal is extracted from the hollow glass tube by means of an electron beam, which scans the entire scene in 1/25th of a second. This electron beam is emitted by an electron gun, which produces electrons and accelerates them towards the sensor target photocathode, which generates a signal proportional to the light intensity on the sensor. Apart from the tube sensor, the remaining camera electronics are solid-state. Tube cameras can provide excellent resolution because the target is a homogeneous continuous surface. However, tube cameras are no longer readily available and therefore this part of SABS 0222 will only concern itself with solid-state cameras.

6.1.3.3 Solid-state cameras

A solid-state sensor performs similarly to the tube camera but has a significantly different sensor and scanning system. Instead of an electron beam scanning the tube, an array of pixels is used. These effectively replace the sensor tube and produce electrical signals in response to the light level of the scene.

Solid-state sensors are available in several types, such as CCD, CPD, CID and MOS. Of these types, the CCD (or charge coupled device) is by far the most popular. Typical sensor format sizes are ¼ inch,an inch, and ½ inch. Some of the advantages of CCD cameras are as follows:

a) There is no geometric distortion.
b) There are no coils, magnets or glass tube.

c) They are not prone to ghosting or image burn.
d) They are more compact and resistant to vibration.
e) They are not affected by electromagnetic interference.

6.1.3.4 Low-light-level cameras

Low-light-level cameras are used to view scenes illuminated by natural moonlight, starlight or some other very-low-light-level artificial illumination. These cameras use image intensifiers connected to imaging tubes or solid-state sensors and are capable of viewing scenes far from the camera under low- light-level conditions. Low-light-level cameras are not infrared (IR) sensitive, are only available in monochrome, cost between ten and twenty times more than a standard camera, and are normally used only in special applications.

6.1.4 Performance specification

6.1.4.1 Resolution

CCTV resolution is the ability of a camera to resolve detail: the higher the resolution the sharper the image. Resolution is measured by the number of horizontal and vertical TV lines that can be discerned in the monitor picture. Vertical resolution is determined by the CCTV format used and is therefore seldom included in camera data sheets. The system used in South Africa is the European PAL format of 625 lines, with a maximum achievable resolution of 408 lines. Horizontal resolution is the resolution quoted in camera data sheets. Unlike vertical resolution, which is limited by the 625 line system, horizontal resolution can be improved by using more pixels in the matrix. Typically, the resolution of monochrome cameras range from 270 to 600 TV lines and that of colour cameras from 330 to 500 TV lines. Generally, the higher the resolution the more expensive the camera, and so correct camera selection for the view required is important to keep costs down. For example, a general view of an area would use a low resolution, but where the identification of people is essential a higher resolution camera would be used.

6.1.4.2 Signal-to-noise ratio

The effect of noise in a video picture depends on the ratio of the noise level to the video signal level. This ratio is expressed in decibels (dB). A ratio of 1 000:1, where the video signal is 1 000 times greater than the noise level, is equivalent to a level of 60 dB. In a video signal, values from 45 dB to60 dB produce an acceptable picture. Less than 45 dB is unlikely to produce an acceptable picture. At 20 dB the picture will be unusable. The signal-to-noise ratio of a camera has an effect on its sensitivity. This is because the better the ratio at a given light level, the lower the minimum light level before the picture becomes unusable.

6.1.4.3 Sensitivity

The sensitivity of a camera is basically the minimum level of light needed to view a picture. The lower the light level, the fewer electrons or charges are produced by the image sensor owing to light falling on it. Sensitivity is usually expressed in lux, which is the density of light measured in lumens per square meter.

There are two main methods of describing the sensitivity of a camera. The most precise, but not very practical, method is to define the face-plate value. The other more common and practical method is for the scene sensitivity to be stated in lux at a given *f*-number and scene reflectance. For example, a CCD camera can have a scene sensitivity of 0,4 lux usable video for a scene reflectance of 75 %(see clause 7) viewed with an *f* 1.4 lens. Obviously a camera will appear more sensitive if the face-plate value is given because no light is lost from the scene or through the lens. That is why care must be taken when looking at camera data sheets to find out exactly what the true sensitivity is. As a guide, face-plate sensitivity is normally 10 times that for scene sensitivity at an aperture of *f* 1.4. The best judgement is, ultimately, how the camera actually performs in the field.

6.1.4.4 Spectral response

Cameras have a range of light to which they respond better than to other ranges and the spectral response of a camera is the sensitivity of the imaging device to the different frequencies of light. Since different camera types respond to different colours, it is important to know what type of light source is illuminating the subject area, as well as what type might have to be added to obtain the required picture quality. More information on this topic can be found in clause 7.

6.1.5 Camera synchronization

All cameras have their own internal synchronization generators to enable the monitor to recreate the picture. However, when more than one camera is being used, switching between camera views on a monitor will produce "picture roll", which at the least can be very irritating, especially if several monitors are in use that all show sequences of cameras.

One method of overcoming this problem is to use an external stable generator to create synchronization pulses. However, a better (and more popular) method is to use line-lock or variable phase locking in which the synchronization pulses are referenced to the AC power supply frequency. Obviously DC cameras cannot use this method and the external generator would be required.

6.1.6 Camera adjustments and controls

6.1.6.1 Automatic gain control

Automatic gain control (AGC) is the process whereby the gain of the video signal is automatically increased if it falls below the "full video" level owing to low light levels. The amplification or gain of a camera is given in decibels – typically 20 dB, which is equivalent to amplifying the signal 10 times.
Most cameras have a switch to enable the AGC to be switched on and off. AGC control is not normally required for internal scenes where the light levels are reasonable and constant.

6.1.6.2 Automatic light control

Automatic light control (or ALC) is normally associated with the use of automatic iris lenses. A separate output on the rear of the camera has a control signal that opens and closes the iris of the lens depending on the amount of light entering the lens, so that the light level onto the image device is always correct.

6.1.6.3 Electronic shutter

The electronic shutter basically switches the charged coupled device (CCD) on and off many times a second. Very rapid switching of the CCD has the effect of reducing the sensitivity of the camera. This can be compared with setting a fast shutter speed on a normal photographic camera. The result is that very rapid movements are captured more sharply on the CCD and when the VCR tape is played back there will be no blurring of moving objects. Using a low shutter speed, on the other hand, will mean that there are less than 25 frames per second and so the camera will not produce moving images. However, it will give more time for light to fall on the CCD and hence increase the sensitivity of the camera to above the normal sensitivity at 25 frames per second. In this way a colour camera can be made to produce usable colour pictures at light levels well below one lux.

6.1.6.4 White balance

A white-balance control is found only on colour cameras as the quality of the colour picture produced by the camera will change depending on the light level and the spectrum of the light on the scene. This control has basically two positions, namely automatic and manual. In the automatic position the camera adjusts itself in terms of the black and white levels of the blue and red signals. In the manual position a potentiometer can be adjusted to vary the picture from blue to red to obtain the right balance. Some cameras have a simple change-over switch to either set the balance for outdoor scenes or to set the balance for indoor scenes that are lit by artificial light.

6.1.6.5 Back-light compensation

A camera with no back-light compensation or with the back-light compensation turned off responds to the average content of the entire video signal. With back-light compensation turned on, the camera establishes a central area for automatic light control. If an object falls within this area, the camera will automatically adjust to set the optimum contrast, thus ensuring a usable picture of the object. This is particularly useful when the camera is directed towards areas of bright light such as doorways, windows and backlit scenes.

However, back-light compensation is not a panacea for problems of this type and its benefits should be treated with circumspection.

6.2 Lenses

6.2.1 General

The function of the CCTV lens is to collect the reflected light from a scene and focus it onto the camera sensor. Choosing the proper lens is very important, since the lens determines the amount of light received by the camera sensor, as well as the field of view and the quality of the image. There are aids available, such as tables, slide rules and the circular lens-finder kit that helps the designer to select the best lens for a particular CCTV application in respect to the field of view required. In addition a focal length finder, calibrated with the different camera formats, can be used to obtain a visual indication of the expected camera view.

6.2.2 Lens mount formats

All cameras have a mount in front of the sensor to mechanically couple the lens to the camera. Earlier tube-type cameras used a standard configuration known as the C mount, whereas new cameras mainly use a new range of lenses that uses a CS mount configuration. The difference between the two types is the flange back length, which is the distance from the back flange of the lens to the face of the sensor. The screw thread and shoulder length of each type of mount are identical, which makes it impossible to see the difference, although the overall size of the CS mount is generally smaller. A C mount can be used on a CS mount camera with an adapter ring, but a CS mount cannot be used on a C mount camera. If the wrong type is used it will be impossible to focus the camera. In addition, some C mounts have a projection at the back that could damage the sensor of the CS mount camera if the C mount is screwed directly into the camera without the adapter ring. A lens designed for a larger format camera (say 1 inch) can be used on smaller format cameras (say b inch, ½ inch), but the reverse is not possible. However, the field of view will be reduced.

6.2.3 Focal length and field of view

6.2.3.1 General

A lens has two focal points, namely the primary focal point and the secondary focal point. The focal length of a lens is the distance from the lens centre to the primary focal point and is expressed in millimetres. The field of view of a lens is the actual area of a picture that can be seen, and is determined by the lens focal length, the sensor size and the distance to the object being viewed. Many lens suppliers provide simple calculators that use the relationship between these factors to determine the corresponding field of view, the most common type of calculator being the disk type. In simple terms, the larger the focal length the narrower the angle of view. Table 1 shows the relationship between lens size and sensor format in terms of field of view. Lenses are available in different focal-length formats, such as fixed focal length, variable focal length, and zoom.

6.2.3.2 Fixed-focal-length lenses

A fixed-focal-length lens has a field of view that is fixed and it normally comes with a manual iris, to adjust the amount of light that passes through the lens, and a manual focusing ring. However, short- focal-length (wide angle of view) lenses often lack a focusing ring or a manual iris. These types of lenses are normally available in focal lengths from 2.8 mm to 75 mm. The angle of view for each focal length can be obtained from the manufacturer's data sheets.

6.2.3.3 Variable-focal-length lenses

A variable-focal-length lens has a limited range of manual focal-length adjustments and is useful in internal situations where precise adjustment of the scene is necessary, especially where the adjustment falls between two standard fixed-focal-length lenses. Variable-focal-length lenses are also useful because, at a small extra cost, one lens type can be specified for all cameras in the system, which gives a saving on installation time and the cost of possible return visits to change lenses if the view is not quite right.

Table 1- Relationship between different lens formats

1	2	3	4	5	6
Equivalent focal lengths (mm)				**Angles of View**	
Sensor size				Degrees	
1 inch	**2/3 inch**	**½ inch**	**1/3 inch**	**Horizontal**	**Vertical**
360	249	181	136	2.0	1.5
280	194	141	105	2.4	2.0
210	145	105	79	3.7	2.6
180	124	90	68	4.1	3.0
150	103	75	56	4.5	3.6
140	97	70	52	5.4	3.9
105	73	53	39	6.9	5.2
100	69	50	38	7.1	5.5
75	52	38	28	9.3	7.3
50	35	25	19	14.3	10.9
30	21	15	11	23.8	18.0
25	17.3	12.6	9.0	28.5	21.6
20	13.9	10.1	7.6	35.1	26.7
16	11.1	8.1	6.0	43.2	33.1
12.5	8.5	6.3	4.7	53.6	41.5
10	6.9	5.0	3.8	65.0	51.1
-	6.2	4.5	3.4	70.7	56.0
-	5.9	4.3	3.2	73.4	58.4
-	5.5	4.0	3.0	77.3	61.9

6.2.3.4 Manual zoom lens

A manual zoom lens is one in which the focal length can be varied manually by means of a ring on the lens body. The zoom ratio is normally stated as being, for instance 6:1, which means that the longest focal length is six times that of the shortest. The usual way of describing a zoom lens is by format size zoom ratio, and shortest and longest focal lengths, for example 2/3 inch, 6:1, 12.5 mm to 75 mm. Care should be taken in establishing both the camera and lens format. The lens described in the example would only have a range of 8 mm to 48 mm on a ½ inch camera.

6.2.3.5 Motorized zoom lens

Motorized zoom lenses are not widely used with fixed cameras as the angle of tilt of the camera often has to be changed as the lens is zoomed in and out. The most common need for a motorized zoom lens is when it is used with a pan-and-tilt camera unit. In this instance the lens zoom ring is driven by a tiny DC motor and operated from a remote controller. With the use of smaller cameras the lens is often much larger than the camera it is attached to and therefore it might be necessary to mount the lens with a rigid support and have the camera supported by the lens.

6.2.4 Lens iris

6.2.4.1 General

A lens iris is an adjustable optomechanical device for controlling the amount of light that passes through the lens and impinges on the sensor device. A lens may have a fixed iris, manually controlled iris or automatically controlled iris.

6.2.4.2 Manual iris

A manual iris has movable metal "leaves" that form the iris. The iris can be manually opened or closed by using an adjusting ring to adjust the amount of light passing through the lens. A lens that uses this type of iris is only suitable for internal applications where the light levels remain fairly constant. This type of iris can also be used with cameras having an electronic shutter feature. In some situations, where the levels of light entering through windows etc. may vary between summer and winter, it might be necessary to adjust the iris during the course of the year to maintain optimum clarity of the picture.

6.2.4.3 Automatic iris

To overcome the light-level problems experienced with manual-iris lenses, automatic irises use motors to automatically drive the iris adjusting ring to compensate for varying light levels. For example, if a scene is too bright the motor will close down the iris, thus reducing the amount of light that can pass through it, until the optimum voltage level of one volt peak-to-peak is reached. Conversely, if the light levels are low the iris will be opened wider to let in extra light. Therefore, in both high-light-level and low-light-level conditions the automatic iris mechanism adjusts to provide the best contrast picture.

There are three main types of automatic iris lenses:

a) **Iris amplifier lens:** this is the most common type and has the amplifier built into the lens body. This amplifier is connected to the video signal of the camera and is driven by a DC voltage (also obtained from the camera), either via a plug-type connection or screw-type connection at the rear of the camera.

b) **Galvanometric lens:** the motor of this type of automatic iris lens is driven by a reference voltage produced by an amplifier located in the camera itself. These types of lenses are less expensive and are simple to install but can only be used on a limited range of cameras. Therefore, it is essential that the camera specification be checked to ensure that it contains the correct circuitry to drive this type of lens.

c) **Sensor lens:** this lens uses a light sensor to measure the light levels and adjust the iris accordingly. This lens is rarely used and it is unlikely that CCTV system designers will have to include this lens in their design.

6.2.5 Aperture and *f*-number

The aperture is simply the light gathering area of the lens, and hence it controls the amount of light that reaches the image sensor. The size of the aperture is mechanically controlled; the more light that passes through the lens and reaches the image sensor, the better the contrast and picture image quality. This light-gathering ability or optical speed is related to the focal length and diameter of the lens and is represented by what is known as the *f*-number. The *f*-numbers, or *f*-stops, are always indicated by the following numbers: *f* 0,8; *f* 1,4; *f* 2; *f* 2,8; *f* 4; *f* 5,6; *f* 8; *f* 11; *f* 16; *f* 22 and C. The C indicates that the iris is closed and no light is transmitted. The lower the *f*-number, the more the light that is transmitted by the lens.

6.2.6 Depth of field

Depth of field is a term that relates to what portion of a picture is in focus and what portion is not, at any given light level or iris opening at specific distances. Factors that affect the depth of field are the focal length of the lens, the *f*-number, and the distance to the subject. The wider the angle of the lens, the more depth of field the picture will have; the narrower the angle (that is, a long focal length), the less the depth of field will be. The higher the *f*-number, the greater the depth of field will be, the lower the *f*-number, the smaller the depth of field will be. The depth of field will decrease when

a) The focal length is longer,
b) The *f*-number is larger, and
c) The subject distance is shorter.

6.3 Monitors

6.3.1 General

Ultimately the picture taken by the camera and the lens, possibly via other video equipment, will be displayed on a monitor. The monitor's performance and adjustment will have an effect on the picture seen by the operator. Video images presented on the monitor have to have a sufficiently high resolution and quality to enable the operator to assess the situation being displayed. Because the monitor is an analogue device, it has settings and control adjustments that enable the best picture to be displayed. It therefore is essential to understand the principles of the normal monitor controls, their effect on picture quality and the correct way to set the controls.

Monitors are available in screen sizes from approximately 5 inches to 20 inches (this is the diagonal distance measured across the monitor's screen) (Note the continuing use of inches to determine monitor size.) The choice of the best size of monitor depends on the viewing distance. If the incorrect size or position of a monitor is used, the monitor will at best be awkward and unpleasant to use; and at worst the picture will be too small to differentiate detail or so large that the picture appears grainy and of low quality. See table 2 for typical monitor minimum and maximum viewing distances.

Table 2 — Monitor viewing distances

Monitor size	Recommended viewing distance cm
5 inch	30 to 60
9 inch	50 to 105
12 inch	60 to 150
15 inch	70 to 180
20 inch	90 to 240

6.3.2 Performance specifications

6.3.2.1 Resolution

As with cameras, the vertical resolution of a monitor is limited to 625 lines. The figure for resolution that is normally given in monitor data sheets is, as for cameras, horizontal resolution. The major difference between camera resolution figures and monitor resolution figures is that the resolution of monitors is given for the centre of the picture. For example, a monitor with a quoted resolution of 600 lines will have 600 lines at the centre of the screen and possibly only 400 lines at the corners. The object to be viewed should be located in the centre of the screen to get the sharpest picture. The horizontal resolution of monochrome (i.e. black-and-white) monitors is normally quite high (between 750 lines and 800 lines), whereas, because of the three colour spots (red, green and blue) that are needed to make each point, the resolution of a colour monitor is lower, i.e. typically between 300 lines and 450 lines.

6.3.2.2 Input impedance and level

The monitor should accept the standard video signal level of 1 V peak-to-peak and also have an input impedance of 75Ω to match the impedance of the camera and the coaxial cable. Ideally, this impedance should be switchable between 75 Ω and high impedance to allow the video signal to be looped into another monitor.

6.3.2.3 Control settings

Monitors have a number of controls that can be adjusted, namely, an on/off switch and controls for brightness, contrast, colour (if it is a colour monitor), vertical hold and horizontal hold, and a termination switch. The recommended procedure to set these controls is given in another the part of this Kenya standard.

6.3.3 Selecting and positioning a monitor

Monitors are normally selected on the basis of their specified performance data. However, the size, viewing distance and positioning of the monitor are just as important as any technical specification. If the monitor is too small or too far distant, it will not be able to resolve the detail and for the viewer the whole purpose of the system will be destroyed. Similarly, if the monitor is too large or too close, the image quality will seem worse than it really is. If the monitor is incorrectly placed or is at the wrong angle it will be uncomfortable for the operator to use. If there are too many monitors the operator will simply not be able to take in the activity on all screens. The topic of allocating the right number of correctly sized monitors in the best positions is covered in the next part of this Kenya standard.

6.4 Video switchers

6.4.1 General

The function of the video switcher in any multiple-camera CCTV system is to connect a specific camera to a specific monitor (or recorder or other device) and display the video image in a logical sequence. The switched pictures on the monitor can be recorded on a VCR or printed on a video printer. The switcher performs a vital function by simplifying system use and maximizing the information presented to the operator. The three basic types of video switchers are:

(a) manual,
(b) Sequential, and
(c) Matrix (or microcomputer controlled).

6.4.2 Manual switcher

The manual switcher is the simplest. The operator manually chooses one camera from a number of cameras (by activating front-panel push buttons) for display on a single video monitor. This type of switcher terminates each camera input with 75 Ω to match the monitor. These switchers are normally available to switch from two to eight camera inputs.

6.4.3 Sequential switcher

The basic homing sequential switcher allows for continuous viewing of any sequenced cameras. The camera signal is connected to a single video monitor. A three-position switch (designated automatic, homing and bypass) for each camera allows for automatic selection and switching from one camera to the next, according to the sequence set by the operator. The length of time for which each camera picture is displayed (known as the dwell time) can be changed by the operator. With the switch set in the home position the selected camera is continuously displayed on the monitor and the sequence stops. The bypass position removes the camera from the display. As with the manual switcher, all camera inputs are correctly terminated with 75 Ω. These switchers are available to switch from 4 to 16 cameras. Variations on this type of switcher include the following:

a) **Bridging sequential switcher:** operates like a homing switcher but has two monitor outputs to allow continuous sequential monitoring at the same time as individual selected viewing;

b) **looping-homing sequential switcher:** operates like a homing switcher but allows for all camera inputs to be brought out to a second switcher or other device at another location;

c) **alarming sequential switcher:** automatically displays a picture on the monitor or starts a VCR each time it is activated by an alarm input; available in homing, bridging, and looping-homing configurations; and

d) **Remote sequential switcher:** this switcher consists of two parts, namely a switching unit that can be situated in a suitable position close to the cameras and a control unit that can be located near the monitor(s). These two units are connected by a two-core or four-core cable, or sometimes a single coaxial cable. The monitor(s) are connected to the remote unit via coaxial cable(s).

6.4.4 Matrix switcher

Matrix switchers are now available to cope with the increasing size and complexity of CCTV systems. These types of switchers are based on microprocessor principles that allow for greater flexibility in routing and processing video signals so that any combination of cameras can be connected to any monitor. In addition, features such as automatic alarm-activated video, pan/tilt/zoom control, time/date generation and text for camera identification are also provided. Matrix-switched systems can range from simple self-contained units that control 16 to 32 cameras and several monitors and keyboards to a very large system that controls 1 028 cameras and 99 monitors. Owing to the wide variety of matrix systems available, it is recommended that a final specification be obtained from the various suppliers or manufacturers. Wherever possible, a schematic diagram of the proposed equipment and control point layout should be provided together with a site layout drawing that shows cable routes and distances. See annex B for the layout of a typical CCTV system that uses a matrix video switching system.

6.5 Video multiplexers

6.5.1 General

One of the problems associated with video sequence switchers is that only the camera that is being displayed will be recorded, assuming that VCR recording is being used. For example, assume that the dwell time is set at 4 s for an eight-camera system and the sequence starts at camera 1. Camera 1 would be recorded for 4 s, then camera 2 for 4 s and then camera 3 for 4 s, etc. Camera 1 would only be recorded again after 28 s, that is, after the seven remaining cameras had been recorded for 4 s each. So, for 28 s no images from camera 1 will be recorded and hence valuable information might be missed. To minimize this loss of information, camera video signals can be multiplexed to provide a faster switching/recording rate with the added functionality of multiple camera display. Pictures from a number of cameras are digitized, temporarily held in a frame store and then converted back to analogue signals and fed in sequence to a video tape recorder. That is, a frame from camera 1 is recorded followed by a frame from camera 2, followed by a frame from camera 3, and so on until the last camera. The sequence is then repeated for all cameras. By using this method, an update time of0.32 s per camera can be achieved for an eight-camera system. This calculation can be explained as follows:

Since 25 frames of video are produced every second in the CCIR standard, the picture is updated every 0.04 s (or 1/25 s in real time). Therefore, for an eight-camera system, the picture from each camera will be updated every 0.32 s (that is, 0.04 s x 8 cameras), and for 16 cameras the update time will be calculated by multiplying 0.04 s by 16 cameras to get 0.64 s.

If these pictures are being recorded on a VCR in the 3 h mode (or real-time mode), the recording of each camera would also be at 0.32 s (for 8 cameras) or 0,64 s (for 16 cameras). However, should the recordings be taking place in a time-lapse mode, the update time would be increased according to the following formula:

$$t = 1/25n*m/3$$

Where

t is the update time expressed in seconds;

n is the number of cameras;

m is the time-lapse mode that has been set.

Example: For a 16-camera system recording in the 24 h time-lapse mode (see 6.6.2), the update time would be:

$$(1/25 \times 16) \times (24/3) = 5.12 \text{ s}$$

NOTE: These are theoretical times as time-base correction could increase them slightly.

It is recommended, in high-security sensitive installations, that the 3 h recording mode be used in order to reduce the update time to a minimum.

6.5.2 Simplex multiplexers

The basic multiplexer provides only one multiplexed output, which can either be directed to the monitor screen or to a video recorder, but not to both at the same time. This ability to perform one of the main multiplexing tasks at any one time, i.e. recording, playback, or live viewing, is known as simplex operation.

6.5.3 Duplex multiplexers

The ability to perform two of the main multiplexer tasks at any one time is known as duplex operation, such as reviewing a video tape while continuing to record all cameras. Obviously two VCRs will be required, one for recording and one for same-time playback. The duplex multiplexer is basically two simplex units packaged as one unit.

6.6 Video recorders

6.6.1 General

A video cassette tape recorder (VCR) is a complex integration of electronics and high-precision mechanics and uses a tape contained in a cassette with a supply spool and a take-up spool. The tape contains thousands of tiny magnets, each with a north and a south pole, and is passed through a varying magnetic field. This field is generated in a revolving drum from the video signal and reproduces the video image on the tape. The standard tape format used is VHS (Video Home System), which was developed by the JVC Company of Japan, and the standard tape cassette used in security CCTV applications is the E180, which records for 180 min at normal speed. The maximum resolution of a video recorder depends on the available bandwidth. Typically, the resolution of a monochrome picture is 330 lines and that of a colour picture is 240 lines. This has the effect that even if high- resolution cameras and monitors are used in the CCTV system, the recording quality will be limited by the maximum resolution available from the video recording equipment. Super VHS recording techniques (that separate the luminance and chrominance signals and create a wider bandwidth) can provide greater resolution than standard VHS (typically 500 lines for colour and 400 lines for monochrome). However, the equipment is more expensive and the cost of the installation increases since additional coaxial cables are required. In addition, there is a limited range of equipment that can switch and multiplex the separate signals required.

6.6.2 Time-lapse recorders

A time-lapse recorder has the ability to record at different speeds, thus extending the overall recording periods. The recording periods can range from 3 h to 960 h. The 3 h, 6 h and 12 h mode records continuously at a slow speed. For recording periods longer than 12 h, the recording takes place in a step mode. In this mode the tape is stepped forward one frame at a time at a rate according to the time selected. For example, a recording at the 72 h mode would playback at the rate of approximately one frame per second. Real time is considered to be 25 frames per second. It should be noted that a person moving at eight kilometres per hour will travel over 2 m in 1 s. The greater the time-lapse mode, the more chance of losing critical information.

6.6.3 Typical features associated with time-lapse recorders

The following is a list of some typical features found in most time-lapse recorders:

a) **Selectable recording mode:** depending on the model, from 3 h to 960 h recording is possible;

b) **Horizontal resolution:** the ability to switch between colour and monochrome to provide higher resolution in monochrome;

c) **Still frame:** the ability to display a single frame for analysis;

d) **Alarm recording:** an alarm input will switch the recorder from a time-lapse mode (or standby mode) to 3 h real-time recording for a defined time;

e) **Alarm search:** the ability to fast-forward until an alarm input is detected;

f) **Time and date:** this information can be superimposed on selectable parts of the screen;

g) **Repeat record:** at the end of the tape it can either stop or rewind itself and re-record;

h) **Time and date search:** the ability to fast-forward the tape to the required part based on the time and date;

i) **End-of-tape alarm:** either a local or remote alarm (or both) to alert a person that the tape end has been reached;

j) **Programmable recording:** to start or stop recording and set recording modes at specific times;
k) **Battery backup:** in the event of a power failure all main settings, such as time and date, programme recording, etc will be retained;
l) **Clock output:** output from an internal synchronization clock to a video switcher;
m) **Series recording:** at the end of the tape an output signal will start another recorder to provide continuous recording;
n) **One-shot recording:** this allows the recorder to be set to record one frame at preset intervals;
o) **Emergency recording:** an external trigger signal will switch a recorder to the recording mode even if the power is off or the recorder is set in the stop position
p)**RS-232 output:** to enable the recorder to be interfaced to other equipment.

6.6.4 Video image/frame storage disk

The real-time or time-lapse video recorder provides the means for serially recording consecutive frames over a period of time. Even with time and date search the time taken to locate a particular scene or incident is usually fairly lengthy, since it requires shuttling a scene backwards and forwards in order to find the required frame. Other storage mediums are available, but are not readily used because they are expensive. However, with ever-reducing costs these alternative devices will eventually replace the analogue video recorders that are so commonly used in security CCTV systems.

Some of these devices are given below:

a) **analogue magnetic-disk image storage:** analogue pictures are recorded on parallel, circular tracks on the magnetic disk and accessed in parallel rather than in series, as required in video tape recording; this greatly reduces the retrieval times;

b) **digital magnetic-disk image storage:** the video images are digitized before storage on the magnetic disk

c) **Optical-disk image storage:** two generic systems are available, viz. the non-erasable WORM (write-once read-many) recording system and the erasable optical disk, optical disks store significantly larger amounts of video data per disk than the magnetic disk.

6.7 Hard-copy printers

The hard-copy printout of video monitor scenes, VCR recordings or other recording media has become an important addition to many security systems. Monochrome and colour printers permit good to excellent quality reproduction of the scene on paper or film-based media. This hard copy is used by security personnel for apprehending an offender, responding to a security violation, for staff dismissal, for use as evidence in a court of law, or for permanent record purposes. Several types of printers are available, the most popular being the thermal and film type. These and the other types are described below:

a) **Thermal – monochrome and colour:** the images are "burnt" into the thermal paper, thus creating a facsimile of the video image. This type of printer is very popular because of its ruggedness, convenience and reasonable price. Both low- and high-resolution printers are available;

b) **Ink jet:** not widely used because of their limited resolution and colour reproduction;

c) **Laser:** does not produce high-quality monochrome images;

d) **High-resolution thermal laser:** expensive and normally used for printing from still images; and

e) **Film – monochrome and colour:** the image is captured in a freeze-frame image-storage device and recorded with a camera that uses a film that produces instant photographs. The resolution and rendition of the image is good. However, film that produces instant photography is fairly expensive.

6.8 Ancillary equipment

6.8.1 Camera brackets

Three fundamental considerations are necessary when selecting a camera bracket, viz. weight, mounting plate, and mounting design.

a) **Weight:** add the weight of the camera, lens and housing (if used) and increase the total by 10 % to allow for the weight of the cabling, and select a bracket that is designed to support this weight or more

b) **Mounting plate:** some brackets come with a swivel-type mounting plate to allow the camera to be aimed in a variety of positions. Some come with a fixed mounting plate, which is ideal for a wide- angle lens camera that is aimed in one position only. One inexpensive type comes with a ball-and- socket adjustable swivel head and mounting bolt and locking ring. Securing the swivel head in its final position is done by using an Allen key. Unfortunately, with this type of bracket installers tend to force the head into the correct position because they do not have an Allen key, and eventually the ball and socket becomes loose and it is difficult to secure the camera in the required position. In addition, the camera tends to move after set up; and

c) **Mounting design:** brackets are available in a variety of mounting designs, such as wall mount, ceiling mount, corner mount, pole mount, and floor pedestal.

Once the area or position (or both) where the camera is to be mounted has been selected, it is fairly easy to select the correct bracket for the job based on the manufacturer's data sheets, which normally include pictures of the various types available.

6.8.2 Camera housings

6.8.2.1 General

Camera housings are available in a variety of shapes, sizes, and configurations and fall into two categories, viz. internal and external. Internal housings protect the camera and lens from tampering and are usually made of lightweight material. External housings protect the camera from environmental conditions, such as extremes of heat, rain, dust and dirt, as well as tampering. However, in both types of housings the lens of the camera should be as close to the front glass as possible to eliminate side view interference caused by the actual housing enclosure.

6.8.2.2 Internal housings

The most popular type of internal housing is the standard rectangular design, as it is inexpensive, sturdy and is available in many sizes and styles. Accessibility to the camera and lens assembly for installation and servicing is important and manufacturers provide one of several means to gain access:

a) Removable top cover;

b) Hinged top cover;

c) Top cover or camera and lens assembly on a slide;

d) Removable front or rear cover (or both);

e) Hinged bottom cover; or

f) Top cover on slide.

A second category of popular housings is the round or hemispherical clear or tinted dome type, in which a camera, lens and an optional pan-and-tilt mechanism are housed. Other housings include the following:

a) **Triangular type**, which is mounted in the corner of a room or at the intersection of two walls and the ceiling

b) **Recessed in ceiling or wall type**

c) **Housings for covert surveillance**, such as sprinkler heads, passive infrared (PIR) detectors, wall signs or wall clocks; and

d) **Speciality housings**
That can withstand high mechanical impact from hand thrown or fired projectiles, extreme high temperature, dust, sand, liquid, and explosive gas.

6.8.2.3 External housings

External housings are often referred to as weatherproof or environmental housings. External housings share many of the same attributes as the internal types, such as accessibility to the camera and lens assembly during installation and servicing, and vandal resistance. The rectangular, triangular and dome-type shapes are also evident. However, the main differences between internal and external housings are the additional requirements that are needed from an environmental point of view. These could include

a) A sun shield fitted on top of the housing in high-heat sunny climates,

b) A heating element for extreme cold conditions or to prevent condensation,

c) Gas pressurization to prevent the ingress of dirt and dust in extremely dirty conditions,

d) Washers and wipers if rain or mist is a problem, and

e) Flame and explosion protection, especially in a mining environment.

Standards are used to specify the degree of protection provided by external housings. The rating of protection is given by a two-digit code prefixed by the letters IP (index of protection). The first digit gives the protection rating against solid objects and the second the protection rating against the ingress of water or liquids. See annex C for index of protection ratings.

6.8.3 Pan-and-tilt mechanisms

6.8.3.1 General

There are basically two camera-mount configurations to point the camera in different directions, namely panning only (or scanning in the horizontal plane), and panning (horizontal plane) and tilting (vertical plane). Most scanning units can pan through a range of 355°, with some capable of panning a full continuous 360°, at a typical speed of 6° per second. Simple scanners are used when interest occurs in a single horizontal plane, such as a wide entrance to a reception lobby area. When coverage is also required in the vertical plane, a pan-and-tilt unit is used. Most pan-and-tilt units can move through a 90° plane at a speed of 3° per second. Units are made for both internal and external use and come with a fixed-speed or variable-speed capability.

6.8.3.2 Mechanical considerations

There are two main types of pan-and-tilt units. The first is a unit where the camera or housing is mounted direct on a platform that forms part of the construction – either mounted on top of the platform or mounted on the side. In the second type of unit the driving components are contained within the same enclosure as the camera, such as a dome housing. Indoor units are generally lightweight and require no environmental protection, and dome units are ideal for use in this application. External housings, however, have to contend with much harsher environmental conditions, such as wind, rain, dust, dirt, corrosion, temperature extremes, humidity and higher levels of vandalism. To successfully cope with these additional burdens the pan-and-tilt mechanisms have to be more rugged and environmentally resistant. It is recommended that the suppliers or manufacturers (or both) of such units be approached for advice so that an appropriate unit can be selected for the application envisaged.

6.8.3.3 Pan-and-tilt control systems

In addition to controlling the pan-and-tilt function of the unit, the operator normally has the ability to control other auxiliary functions, as well as functions of the camera associated with the unit. This combination of a pan-and-tilt mechanism with camera control is normally referred to as a PTZ camera.
The following functions are typical examples of the types of control that are available:

a) Pan;

b) Tilt;

c) Zoom;

d) Focus;

e) Iris;

f) Camera on/off;

g) Preset positions; and

h) Other auxiliary functions (heater, washers, wipers, etc.).

There are four basic techniques that can be used to control a remote pan/tilt-and-zoom (PTZ) unit, viz.:

a) **Hard-wired multicore:** this uses a multicore cable connected direct between the operator's control equipment and the PTZ unit. Each core of the cable will carry a dedicated command signal, such as pan left, pan right, zoom in, zoom out, etc.;
b) **Hard-wired multiplexed:** this uses a physical twisted-pair direct connection. The control signals are multiplexed (or combined) at the control end and demultiplexed (or separated) at the PTZ camera position to provide the individual signals to drive the unit functions;
c) **Coaxial multiplexed:** the multiplexed signals are transmitted over the same coaxial cable that is used for the camera video signal
d) **Wireless:** the control signals are transmitted by means of normal RF radio techniques, or via microwave or infrared communication links.

6.8.4 Screen splitter

6.8.4.1 An electronic image-splitter device is a control unit interposed between the camera (or switcher) and the monitor, VCR, or printer. It combines parts of the scenes of two or more cameras and displays them on one monitor. The use of the inexpensive image splitter increases security in two ways:

a) The screen splitter reduces the number of recorders required, since it combines several scenes onto one video signal.

b) It permits the operator to view a monitor with two or more scenes on it rather than one.

6.8.4.2 The electronic or optical screen splitter takes a part of several camera scenes and combines them for display on one monitor. This type of splitter does not compress the images and requires that the video signals be synchronized. Whereas the majority of splitters now use image compression techniques (synchronization of cameras is no longer a requirement) to compress and display two or more full video scenes on one monitor, equipment is available to compress 4, 9, 16, or 32 full video images onto one single video monitor. The most common equipment in use is the quad combiner, which has four cameras; the complete original picture is compressed into one quarter of its original size (half width and half height). The resolution is likewise reduced to one-fourth of its original. There are many features available with this type of equipment and it is essential to check the manufacturer's literature for particular models. It is possible to spend more than necessary if a model is selected that has more features than are required. Some of the features available are

a) Electronic zoom,

b) Sequential switching,

c) Dual monitor outputs,

d) Alarm inputs,

e) Camera titling,

f) loop-through switchable terminations,

g) On-screen menu, and

h) video-loss signal.

6.9 Video transmission

6.9.1 General

Video signal transmission is a key component in any CCTV system. Most systems use coaxial cables, but optical-fibre cable is fast gaining acceptance because of its better picture quality (especially with colour) and the lower risk factor with respect to ground loops and electrical interference. Other techniques are also available, such as microwave and infrared. See annex D for a diagrammatic representation of various video transmission methods. A review of the principles of operation of the various types of video transmission methods is given below.

6.9.2 Coaxial cable

Coaxial cable type RG59 is the most widely used video transmission medium for short to medium distances (that is, up to approximately 300 m). For distances up to 900 m coaxial cable type RG11 should be used. These types of cable have a single conductor with a characteristic impedance of 75 Ω, and the video signal is applied between the centre conductors and a coaxial braided or foil shield. Cables are available in many different mechanical formats, including single-wire armoured and irradiated PVC-sheathed cable for direct burial. Cables are also available with different performance ranges, from relatively poor to excellent. Performance is normally measured in high-frequency loss per100 m. The lower this loss figure, the less the distortion of the video signal. Therefore, higher quality cables should be used when transmitting the signal over long distances.

6.9.3 Twisted pair

The primary purpose of using balanced twisted-pair cables is to increase transmission range and to eliminate the picture degradation found in some coaxial applications. Advantages of using twisted-pair cables include

a) The ability to reject unwanted interference,

b) Lower losses at high frequencies per unit length,

c) Smaller size,

d) Availability of multipair cables, and

e) Lower cost.

However, the advantages have to be considered in relation to the cost of the additional equipment required for this type of transmission. A launch amplifier to convert the video signal at the camera end and an equalizing amplifier to reconstruct the signal at the control end are needed.

6.9.4 Microwave

Microwave systems are radio systems that use frequencies in the gigahertz range and therefore require an unobstructed line-of-sight transmission path. Any metallic or wet objects in the transmission path causes severe attenuation and reflection, often rendering the system useless. Even when a line-of-sight path exists, there can be signal fading that is caused primarily by changes in atmospheric conditions between transmitter and receiver units. Normally there is one transmitter and one receiver for each camera, which makes this type of transmission system expensive. In addition, licensing by the relevant authorities is required. However, when it is not possible to make a direct cable connection between the camera(s) and the control position, and especially when real-time continuous monitoring is required, this method of video transmission can be considered.

6.9.5 Infrared radiation

One of the latest methods of video transmission is the infrared link. Infrared radiation can be used to transmit signals over long distances and is unaffected by electromagnetic interference. Although infrared links offer a cost-effective method of free-space transmission, with no licensing required, they do require a clear line of sight and are affected by adverse weather conditions and certain environmental conditions, such as smoke.

6.9.6 Optical fibre

In optical-fibre transmission the video signal is converted from electrical impulses into pulses of light that are then sent down a glass optical fibre. Optical-fibre links offer quality signal transmission, reliability and immunity from electromagnetic interference. Optical-fibre transmitters and receivers are required to convert electrical signals into light signals and vice versa. In addition, the optical-fibre cable has to be terminated correctly to ensure optimum operation. The multiplexing of video signals with data and audio signals that travel in opposite directions simultaneously is possible with this method of transmission. This makes optical fibre very suitable for pan, tilt and zoom applications. Two common types of fibres are used for CCTV installations, namely

a) **Single mode:** small in diameter, producing few reflections of light and used for long transmission runs of many kilometres, and

b) **Multi-mode graded index:** larger diameter, producing many reflections of light, and used extensively in CCTV security applications.

The advantages of using an optical-fibre transmission system, includes the following:

a) Complete electrical isolation between the camera and related equipment from the control end, i.e. the monitor, recorder, printer, etc.;

b) Immunity from radio-frequency and electromagnetic induction interference;

c) Inherent transmission security;

d) No fire hazards;

e) Absence of crosstalk; and

f) No radiation of radio frequency and electromagnetic induction interference.

6.9.7 Telephone network

There are two main methods of transmitting speech and data through the Telkom telephone network, namely the public switched telephone system, or PSTN (also referred to as PABX) and the integrated-services digital network, or ISDN. The fundamental difference between the two systems is that the PSTN uses analogue signals and the ISDN uses digital transmission. The benefit of ISDN is a speed of transmission that is many times faster than that of the PSTN.

Reasons for using the Telkom network include the following:

a) No line-of-sight requirements as in the case of infrared or microwave links;

b) Distance too great for either of these methods;

c) Not necessary to maintain continuous monitoring of a site;

d) To remotely verify the status of a site in the event of an alarm; and

d) To periodically "patrol" a remote site from a central station.

Both PABX and ISDN require additional equipment to allow connection of the video images to the relevant transmission network. This equipment is needed to convert the video signal into digital information, to transmit and receive the digital signals and then to convert the digital information back to the video format at the receiving end. It is even possible to control pan-and-tilt cameras over the same networks using similar transmission techniques.

6.9.8 Selection of appropriate video transmission system

6.9.8.1 The most economical and most common method of video transmission is by coaxial cable. Owing to cable characteristics, the higher frequencies are attenuated (video signal loss) and it might be necessary to install equalizing equipment to restore resolution and contrast on long lengths of cable. In addition, it might also be necessary to provide a video amplifier to boost the video signal level when the distance exceeds the recommended cable length. This amplifier is normally installed at the camera location. As an alternative to using coaxial cables on long runs, balanced twisted-pair cables can be used quite successfully.

6.9.8.2 In applications where the running of cables is not desirable or feasible and a line-of-sight path is present, an infrared or microwave system may be used. Different models are available based on cost, path distance and frequency band. In most instances a licence will also be required.

If a cable can be used and coaxial cable is not a good choice owing to distance, conduit space, interference, ground loops, or security-signal concerns, a multi-mode graded index optical-fibre cable transmission system can be used. Optical-fibre equipment is cost-sensitive to the distance and each transmission path should be analysed to optimize the design.

When visual verification of an alarm initiated from a remote site is required or "remote" CCTV patrol of a site, or when the distance between the camera system and the monitors and control equipment is very great, the existing telecommunication telephone network can be used.

7 Lighting considerations

7.1 General

Ambient light, by itself, is not sufficient to provide adequate illumination for exterior video assessment for other than low-light-level cameras, such as the silicone intensified target (SIT) or intensified CCD (ICCD) types of camera. These cameras operate at significantly lower light levels than the best tube or solid-state cameras. Any intensified camera is expensive and should only be considered for critical security applications. Therefore, the following lighting information is based on CCTV installations that use standard types of video camera. Technical information in respect of specialized low-light-level cameras can be obtained from the relevant manufacturer or supplier.

7.2 Lighting requirements

Four important requirements should be considered when a lighting system for a typical CCTV installation is designed, namely horizontal luminance, vertical luminance, uniformity ratio, and lighting spectrum.

a) **Horizontal luminance**, i.e. the light incident on a horizontal plane: the intensity of this light has to be sufficient to provide adequate face-plate illumination to the camera. This is a function of not only the camera sensor device but of also lens speed (the f-number), lens quality and scene reflectance. This relationship can be expressed by the following equation:

$$I_s = \frac{4 \times I_{fp} \times f^2}{R \times TR}$$

Where

I_s	is the scene luminance, expressed in lux (see note 1);
I_{fp}	is the sensor face-plate luminance, expressed in lux;
f	is the lens *f*-number;
R	is the reflectance of the scene, expressed as a percentage (see note 2);
TR	is the lens transparency ratio (or efficiency) (see note 3).

NOTE 1 :Table 3 lists some typical lighting levels found in various environments. These levels should be considered as a guide only and are not definitive in any way. Actual light levels should always be checked (by using a light meter), including the variation from the lightest to the darkest. In contrast to these artificial light source levels, natural lighting levels range from 100 000 lx for bright sun to 0.0001 lx for clear starlight.

NOTE 2: A camera only sees light reflected back to it from the subject of the scene. Only an optically perfect mirror will reflect back 100 % of the light that shines on it. Anything else is comparatively poor at reflecting light. When light strikes a scene or an object, some is absorbed, some is diffused in scattered directions and some is reflected back to the camera. The amount of light reflected back to the camera is defined as a percentage of the light that illuminates the subject. This is the reflectance of the scene. Some typical values are given in table 4.

NOTE 3: The lens *f*-number (or *f*-stop) is simply a ratio of the focal length to the effective diameter of the lens and although it is the measure of the amount of light that the lens will pass, it is not a measure of the quality or efficiency of the lens. The measure of efficiency of the lens is known as the transparency ratio and would typically be 0,85 for a high- quality lens and 0,6 for a cheaper lens.

b) **Vertical luminance:** this is the light incident on the vertical plane. This light has to be intense enough to provide good contrast between an object in the scene and the background. The required lighting level is difficult to estimate; however, for most exterior lighting systems that satisfy the horizontal illumination requirements, vertical luminance is at an adequate level.

c) **Uniformity ratio:** equal in importance to luminance levels, but often not considered, is the ratio of the highest luminance to the lowest luminance in the scene. If the light/dark ratio is excessive, lighter areas will provide too much light, causing blooming or wash-out of details. Likewise, the darker areas will not provide sufficient light for good resolution. As a general rule of thumb, the uniformity ratio for external lighting should be less than 5:1. This includes the entire area observed by the cameras and not just the area of interest, i.e. lighting has to extend beyond corners and fences to provide even illumination over the full field-of-view of the camera.

d) **Lighting spectrum:** camera image devices are similar to the human eye in that they are sensitive to only a limited band of the electromagnetic spectrum. If the light-output spectrum and the camera imaging device spectrum sensitivity are different, more light might be required to provide adequate illumination.

Table 3- Luminance in typical environments

1	2	3
Environment	**Type**	**Luminance lx**
Manufacturing Assembly	Rough Medium Fine	200 500 1000
Banks	Lobby Office and cages	200 500
General buildings	Dining rooms Halls and corridors Outdoor entrance	100 150 30
Hospitals	General Surgery Operating table Examination table	500 18000 500
Manufacturing inspection	Rough Medium Fine	200 500 1000
Offices	General Accounts	500 750
Hotels	Bars Restaurants Kitchens	150 100 500
Parking areas	Outdoor night Garage	10 50
Retail stores	Small Large	200 500
Warehousing	Good lighting	100

Table 4- Reflectance of common materials

1	2
Scene Material	**Reflectivity**[a] **%**
White plaster	90
Snow	85
Glass windows and walls	70
White matt paint on concrete	60
Unpainted concrete	40
Parking area with vehicles	40
Red brickwork	35
Open country, trees, grass, etc.	20
Empty asphalt area	5
Clothes	15-30
Human face	15-25
[a] Within the visible spectrum: 380 nm to 780 nm.	

7.3 Beam angle

Another important characteristic when determining the amount of light that reaches a scene, is the beam angle over which the light source radiates. Light sources are classified by their light-beam pattern. This can range from a narrow beam of a few degrees, to a wide beam of 30° to 90°. It is best to match the camera-lens field of view to the light-beam radiation pattern in order to obtain the best uniformity of illumination over the scene. If a large area is to be viewed, either a single wide-beam source or multiple sources have to be located within the scene to illuminate it fully and uniformly. Most lighting manufacturers can provide the coefficient of utilization (CU) for a specific luminaire.

7.4 Spectral characteristics

Every natural and artificial light source has a unique output spectrum of colours, which might or might not be advantageous to a particular camera. Monochrome (or black-and-white) cameras for the most part cannot perceive the colour distribution or spectrum of colours from different light sources. The picture quality of most monochrome systems depends solely on the total amount of energy emitted from the lamp source, i.e. energy that the camera is sensitive to. For a colour camera to see all the colours in the visible spectrum, the light source has to contain all the colours of the spectrum. To obtain a good colour balance, the illumination source should match the sensitivity of the sensor device. Broadband light sources, such as tungsten, tungsten halogen and xenon, produce the best colour images because they contain all the colours in the spectrum. Narrow-band light sources, such as mercury-arc or sodium-vapour lamps, do not produce a continuous spectrum of colours, with the result that colour is rendered poorly. A mercury lamp has little red output, and therefore red objects appear nearly black when illuminated by this type of lamp. Likewise, a high-pressure sodium lamp contains large quantities of yellow, orange, and red light. So a blue or blue/green object will appear dark grey or brown in this light. A low-pressure sodium lamp produces only yellow light and is consequently unsuitable for colour CCTV. Spectral characteristics of lamps and camera imaging devices are given in figure 1 and a summary of typical lamp types and their suitability for use with monochrome or colour cameras (or both) is given in table 5.

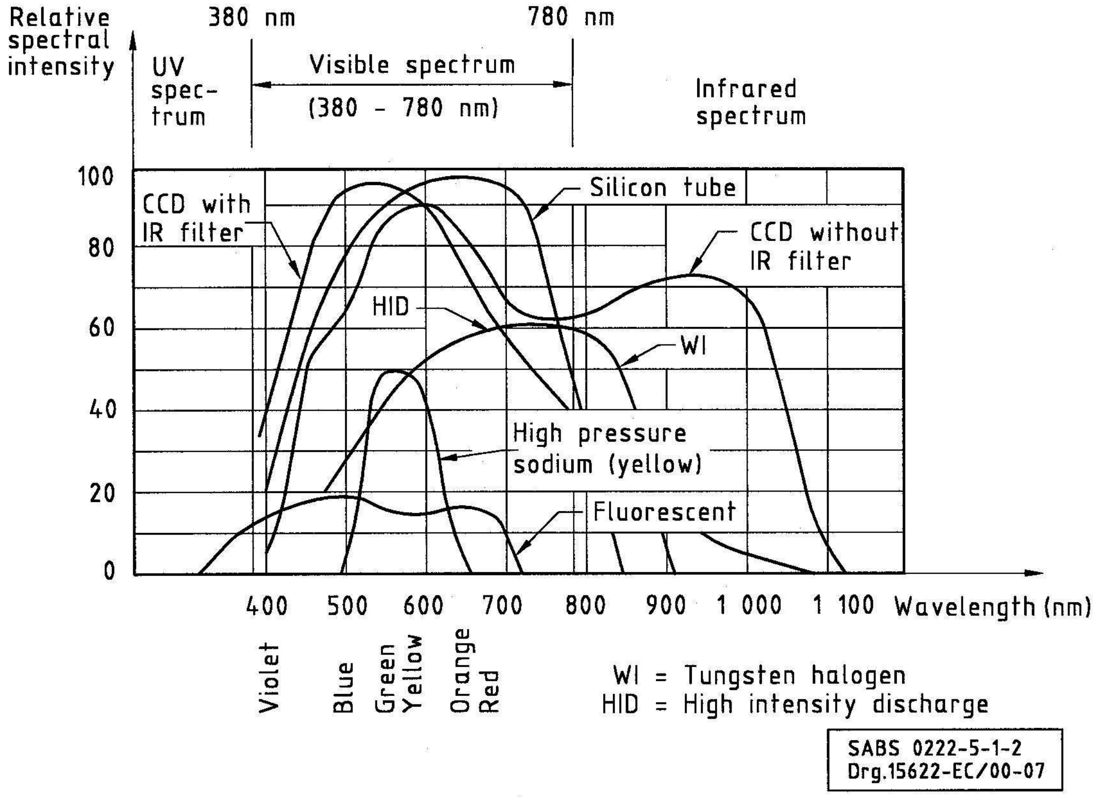

Figure 1 — Spectral characteristics of lamps and camera imaging devices

Table 5- Lamp type and camera suitabilty

1	2	3
Lamp type	**Suitability**	
	Monochrome	**Colour**
Tungsten	Yes	Yes
Tungsten-halogen	Yes	Yes
Xenon	Yes	Yes
HID-Mercury	Yes	N o
-Metal Halide	Yes	Yes
- High –pressure sodium	Yes	No
Low- pressure sodium	Yes	No
Fluorescent	Yes	Yes
Compact fluorescent (CFL)	Yes	Yes

7.5 Infrared illumination

7.5.1 General

There are many situations where it is not practicable or desirable to provide adequate lighting levels by conventional methods. It could be that the camera observes large areas that are impracticable to illuminate. In other situations the presence of the illumination might have to be discreet, for example when the presence of a security system would attract unwanted attention, would alert intruders to the CCTV system, or could disturb neighbours on adjacent properties. In these instances the necessary illumination could be provided by a covert infrared lighting system. Typically an infrared lamp is fitted with a tungsten filament bulb, as the filament burns at a higher temperature and emits more light. The bulb is mounted in a special housing that has a toughened glass filter fitted at the front. The colour of the filter determines what wavelengths of light can be passed. The common wavelengths used in CCTV systems are 715 nm, 780 nm, 830 nm and 850 nm. As the visible part of the spectrum goes to approximately 780 nm, lamps with a 715 nm filter will show a dull red light. Lamps with emissions above 780 nm will show no visible light and are known as black lamps.

7.5.2 Power output of infrared lamps

Lamps are available in a wide range of power outputs, from 50 W to 500 W, the most common being the types in the range 300 W to 500 W. These lamps tend to produce a considerable amount of heat, which is wasted energy owing to the inefficiency of the reflector in reflecting the infrared energy. The life of the bulbs is also short, which makes this type of illumination fairly expensive. There are infrared lamps on the market that are far more efficient than the traditional design. These are usually fitted with miniature bulbs that operate on 12 V d.c. and have special gold-plated reflectors that reflect much more of the infrared spectrum forward, thus resulting in less heat loss. These lamps range from 20 W to 300 W and can be of the spot type, medium-angle type or wide-angle type. The bulb is twice as efficient in the transmission of infrared light. Thus, a 200 W special bulb will give out an illumination level equivalent to a 400 W standard bulb.

7.5.3 Infrared lamp data

Camera manufacturers give data on sensitivity in lux (which is a measure of visible light) and therefore it is not easy to calculate the required illumination levels for a CCTV system when an infrared lighting scheme is designed. Two important factors have to be considered, namely the efficiency of the reflector (and hence the resultant energy loss), and the fact that many lamps are run at a voltage below their rated value to provide a longer life. It is recommended that guidance be obtained from the relevant lamp manufacturer in respect of data such as the intensity of the light source, the angle of the beam, expected light levels at various distances from the light source, the design of reflector and the type of lamp to be used. Even with good input from this expert source, tests on site are often the only way to be sure that the lighting design is effective.

7.5.4 Dual-camera technology

Since no visible light is present under infrared illumination, only monochrome images can be seen. If monochrome cameras are being used for daylight observation, they can also be used when infrared lighting is used. However, if colour cameras are being used under daylight conditions, additional monochrome cameras would be required to observe the same scene if infrared lighting is being used. To overcome this limitation, several camera manufacturers offer a dual camera that provides high- resolution colour images, even in low-ambient-light-level conditions, and the ability to switch either manually or automatically to high-resolution monochrome operation when the camera is used with infrared lighting.

7.5.5 Alternative illumination technique

A new generation of devices composed of an array of gallium arsenide (GaAs) semiconductor diodes that emit a narrow band of infrared radiation and no visible light is being used for covert security surveillance. These devices are very efficient and operate just above room temperature. Since they dissipate little heat, they require no special cooling considerations. The output power from each diode adds linearly, with the sum total illuminating the target scene with sufficient infrared energy to produce good quality CCTV images with solid-state or tube cameras. Generally, several hundred diodes (mounted on a plane) are required to illuminate a CCTV scene. At present, this method of illumination is being used for interior covert surveillance, although it is not yet in general use.

7.6 Lighting design considerations

The initial step to be taken when designing a lighting system for use with CCTV cameras is to determine the level of lighting required. Once this requirement has been determined, manufacturers and suppliers of lighting equipment can be consulted in terms of the actual design. Many of the larger suppliers have access to computer programmes that can model suitable lighting systems. Factors that will determine a cost-effective design will include initial installation costs, operating costs (energy usage), maintenance costs (such as lamp life and labour costs), and the security risk due to the unavailability of adequate lighting.

Initial installation costs are lowest for incandescent lighting, followed by fluorescent lighting and then high-intensity-density (HID) lamps. Generally, there is a significant saving in operational costs (energy costs) between the high-pressure sodium and fluorescent lamps as compared with the mercury vapour and standard incandescent lamps. High-pressure and low-pressure sodium lamps and the HID mercury vapour lamps have a much longer lamp life than the incandescent types, which are relatively low. The lamp life of fluorescent lamps lies between these two extremes. If changing lamps is inconvenient or costly, high-pressure sodium should be used in place of incandescent types wherever possible. Data with respect to the installation, operating and maintenance costs can be obtained from the relevant manufacturers or suppliers of the particular lamps being considered.

If possible, a final lighting configuration should be tested by the installation of a minimum of 10 fixtures for actual measurement and hence evaluation of the design. Adjustment and modification of the total lighting system after installation should be anticipated, as it is not uncommon to discover during camera testing that there are spurious reflections, bright spots, etc. that have to be corrected.

8 Control-point configurations

8.1 General

The effective operation of any CCTV system will depend on the operator, i.e. from the simplest system, in which the operator could well perform other functions (for example, the small retailer), to the most sophisticated system, in which dedicated operators are employed. However, in both instances the operator will have to respond when something unusual occurs. Operating knowledge is therefore required by any type of CCTV system operator. In large CCTV systems it is essential that suitable working conditions be provided in order to maximize operator performance and minimize human failure. This section will deal with those key issues that should be addressed when designing a control room for a major CCTV system. However, the recommendations can also be adopted with suitable modifications for use when smaller control rooms are being designed.

8.2 Operational considerations

8.2.1 General

While the system equipment may perform optimally, any failure on the operator’s part will lead to a performance degradation of the entire CCTV scheme. Key issues that need attention are job design, equipment design, picture formatting, and the layout design of the actual monitoring environment.

8.2.2 Job design

The job design of a CCTV operator should be developed around four distinct areas, namely

a) Definition of what the surveillance system should be looking at (that is, what you want the operator to look at or look for),

b) Definition of how surveillance should be carried out in order to heighten the attention span and increase sensitivity towards potential incidents,

c) A description of what indicators the operator should tune into in order to recognize incidents in progress,

d) Definition of how the operator's performance is to be measured; this will be aimed at motivating operators, diagnosing performance issues and problems, and identifying development needs of both the operator and the system.

A review and amendment of the operator's job description could also result from a change in any of the above-mentioned four areas.

8.2.3 Equipment design

Monitors should be easy to view and control panels should be simple and straightforward to use. Although it may sound obvious, all too often switches all look the same, legends are too small and joystick controls are unprotected and easy to inadvertently disturb. Designers of these control panels also frequently forget that they have to be used under stressful conditions or in reduced lighting. Therefore, the design should allow for visible legends with keys laid out for easy and quick execution of the functions.

Video monitors are a critical interface between the camera and the operator. It is therefore pointless to use sophisticated camera technology if the quality of the picture on the screen is reduced by a poor- quality monitor. Poor visual recognition and operator fatigue is reason enough to provide good quality monitors.

8.2.4 Picture formatting

All too often operators are faced with an unstructured bank of pictures where the actual order of images can relate to something as arbitrary as camera number or the arrangement left by a previous operator. It is essential to rationalize and structure the visual information. Monitors grouped by site location or predetermined routines of camera observation will make it easier to detect changes. A well thought-out arrangement can also pre-alert the operator to the action required when an incident is detected.

8.2.5 Monitoring environment

8.2.5.1 Monitor positioning

The traditional console is giving way to desktop arrangements. The benefits of these arrangements are flexibility, accessibility and easier replacement of monitors. The main problem with this approach is the use of multiple monitors and still having sufficient desktop space for control operations. Monitor banks provide a general overview that can then be followed up on a primary monitor for incident detection. This monitor will be provided directly in front of the operator.

When a console is used, it is normal to place the monitor bank well above the operator's eye level. The need to operate controls and communication devices while staring upwards is physically uncomfortable and is disliked by operators for this very reason. It typically leads to the operator moving away from the console and leaning back in order to view the screens, with the concomitant negative implications for viewing clarity and access to controls. Should this method of installation be necessary, it is recommended that the monitors be placed no more than 25 degrees above the straight viewing plane of the operator.

8.2.5.2 Number of monitors

The depth at which targets appear in the video image has an influence on detection rates, and with more monitors observers are less likely to detect targets at greater depths within the image. This indicates that the greater the risk and the more subtle the behaviour to be detected, the fewer monitors should be used. It is recommended that no more than five monitors be used for one operator.

8.2.5.3 Camera display handling

In an attempt to control the amount of information coming to the operator from cameras via monitors a number of solutions are possible. The simultaneous display of multiplexed images on a single monitor allows greater coverage but leads to major deterioration in image clarity. In high-risk situations where visual clarification is necessary this option is not recommended. Another alternative is the auto cycling of images from different cameras, where the image on screen is replaced every few seconds by one from another camera. However, critical images could be missed owing to the auto cycling sequence. The detection of movement by peripheral vision is best achieved with fixed or static pictures and auto cycling is likely to negate this ability.

The most effective method of directing multiple-camera information through to a single monitor is the use of blank-screen technology, but this is effectively limited to alarm-type conditions, where the screen activates in response to an alarm input or the movement or presence of a person in a particular location. The use of blank-screen technology, while useful, is also contentious in terms of positioning. Having blank screens alongside the primary monitor is not only distracting but causes visual discomfort for the operator.

8.2.5.4 Seating design

Seating design should ensure comfortable and accessible access to the operator's work station, including reach distance to the control apparatus, under-counter leg space, and angle-of-sight to monitors. The use of chairs that are mobile and offer a reclining position are preferred.

When using 14 inch monitor screens it is recommended that the viewing distance be between 0,5 m and a maximum of 2 m. Larger monitors allow more flexibility in distance and are therefore recommended for monitoring tasks.

8.3 Control-room layout

Poor control-room layout can undermine the investment put into high-grade CCTV systems. For example, if the screens cannot be seen properly, efficiency will be compromised. Selecting the right shape and size of room can go a long way to ensuring that a workable layout can be achieved. If possible, rooms that are square and allow for approximately 10 m of space per operator should be selected. Rooms with pillars or with strongly angled walls should be avoided. There is ample evidence that people do not like working in windowless environments, from a psychological point of view. Therefore, it is recommended that windows be included in the design of the control room. Such windows do not have to be large or directly in front of the operator; they should allow operators some contact with the outside world in terms of whether it's sunny, raining or dark. In addition windows should not be so situated as to cause on-screen reflections. Blinds or other screening methods for the windows should be available.

The control room will also be associated with other space facilities, such as an equipment room, a video review room, toilets, kitchen and a rest area. Access into the control, equipment and review rooms has to be strictly controlled to prevent unauthorized entry.

8.4 Environmental considerations

8.4.1 General

Concentration, screen visibility and hearing voice communications can all be linked to such environmental factors as room temperature, air movement, lighting and ambient noise levels over which the designer has some control.

8.4.2 Room temperature and air movement

Hot, stuffy rooms are not conducive to keeping operators alert. Avoidance of excessively high temperatures, the maintenance of adequate airflows and a good quantity of fresh air can do much to keep operators alert. Air temperatures should be increased in the early hours of the morning when the human body temperature drops.

8.4.3 Lighting

The best current practice for CCTV control rooms is the use of indirect lighting. With these schemes the light sources are shone onto the ceiling with the reflected component providing the working light source, which is largely glare-free, soft and shadow-less illumination. Down lighting, which gives a balanced illumination with a dimmable capability within the range 50 lx to 300 lx on the work surface, is also acceptable.

8.4.4 Ambient noise

Controlling noise at source is preferred, such as using hoods over noisy printers. However, by careful specification of interior room finishes, ambient noise can be reduced to acceptable levels. Suppression of noise frequencies that are known to interfere or mask voice communication can also be introduced.

8.5 Operator selection and training

It has been traditional in many service industries to put those members of the staff who can no longer perform their normal jobs satisfactorily into the control room. Fortunately, it has now been recognized that proper selection and training of control-room operating staff is considered essential if the control function is not to become the weak link.

Some of the selection factors that have to be taken into account when an applicant is being considered for a control-room post should include an ability to work under pressure, vigilance capabilities and the ability to perform under widely fluctuating work levels.

Training should be so designed as to ensure that operators become fully conversant with the use of all items of equipment and be able to deal with any operational circumstances that might confront them. Coping with equipment malfunction and novel situations should form an integral part of such training programmes. The use of simulation techniques and role playing can be used, as well the more traditional approach of having a trainee sitting alongside an experienced operator to learn the necessary skills.

9 Power supply considerations

9.1 Power sources

CCTV equipment operates from either an alternating current (a.c.) or a direct current (D.C.) power source. The power source type and voltage level used depends on the equipment chosen and the intended application. By far the most convenient power source available for CCTV equipment is the mains supply. When it is necessary to locate equipment remote from the power source, it is often convenient to use a.c. equipment that operates on 24 V obtained through a step-down transformer. The main advantage of using a 24 V a.c. power source, apart from the obvious safety reasons, is that the power source can be fitted by anyone and a qualified electrician (that is, one holding a wiremans' licence) is not required. If equipment is designed for use with a D.C. power source, such as some CCD cameras or small covert type cameras, a 12 V D.C. power source is used. One such power supply per camera is needed. This supply can be derived from an a.c. source that uses an a.c.-to-d.c. converter or power supply, or from a battery.

To protect the CCTV equipment from external, deleterious electrical noise, surge protectors or power conditioning equipment is used.

9.2 Power supply problems

9.2.1 General

Power supply problems can be defined as any irregularity, disturbance or interruption that is induced in or that occurs along a power line. These problems range from microsecond faults, voltage dips and surges, line spikes and brownouts, to common electrical noise and line-frequency harmonics. Although the power generated by the power utility (such as Eskom) is closely regulated with regard to amplitude and frequency, voltage distortions and disturbances can and do occur.

9.2.2 Voltage surges

A voltage surge is a temporary rise in amplitude that usually lasts at least one half cycles (1/100 second). This type of disturbance is usually caused when high-powered electrical equipment is switched off.

9.2.3 Voltage spikes

When lightning strikes a power line or the ground nearby, a large, damaging voltage pulse can enter electronic equipment and destroy everything in its path. While the spike might last only a few milliseconds, it can reach thousands of volts.

9.2.4 Voltage dips

A voltage dip is the opposite of a voltage surge. During a voltage dip, the line voltage decreases for a short period that lasts at least one half cycle (1/100 second). Dips are usually caused by a sudden increase in electrical load or dissipated power.

9.2.5 Brownouts

During periods of unusually high power demand the power utility might be forced to reduce the line voltage by up to 15 %. This has the same effect as a prolonged voltage dip and can create many forms of abnormal behaviour and equipment failure.

9.2.6 Blackouts

The ultimate power problem is a blackout, when the power is lost completely and the equipment that relies on it ceases to operate.

9.2.7 Electrical noise

Electrical noise is generated by such items as lightning, radio transmitters, poor brush contacts on d.c. motors and many other electronic devices that have switching power supplies. Electrical noise disrupts the smooth sinusoidal power-line voltage and adds many sharp-edged, high-frequency voltage changes.

9.2.8 Power conditioning equipment

9.2.8.1 General

Preferably, owing to the above potential problems, video equipment and other sensitive electronic devices should not be connected direct to the raw power source. If at all possible (cost is normally a limiting factor), power-line conditioning and filtering equipment should be provided as part of the power distribution design. This will provide a source of continuous uninterrupted power at all times, including during complete blackouts. This is especially important when a CCTV system is used in a high-rise area or where continuous surveillance is essential.

9.2.8.2 Uninterruptible power supplies

Uninterruptible power supply (UPS) equipment is categorized by output power capacity and generally configured for continuous duty or standby operation. In the first type, power is supplied continuously to the load by a device called a static converter, which obtains its power from a storage battery. The battery charges itself continuously through the incoming power line.

Traditional types of UPS systems simply convert the incoming a.c. power to d.c. by using rectifier and charging equipment, to charge a bank of batteries and provide direct current to a d.c.-to-a.c. converter that, in turn, provides the a.c. power to the electronic equipment. Unfortunately this type of UPS system is prone to failure and its conversion efficiency rate is fairly low (in some cases as low as 60 %of original power input). To overcome these shortcomings, constant-voltage ferro-resonant trans- former and sophisticated line-sensing equipment were added to modern UPS designs. This transformer cleans up the raw line power, which eliminates spikes, dips, surges, noise and minor brownouts or drops in voltage. In addition to this power conditioning effect, the efficiency of the UPS system increases to 90 %, a higher reliability is achieved, cost savings can be obtained (the design is simpler and smaller), and owing to the transformer's so-called "flywheel effect" no break in the supply output voltage is detected by the electronic equipment.

A decision has to be made, preferably when the operational requirements are being determined, as to whether the proposed CCTV system has any essential camera, monitor or recording equipment that has to continue operating in the event of a power failure. If so, a UPS system has to be provided. It is recommended that the design of this type of system be carried out by a qualified electrical engineer.

9.2.8.3 Lightning and surge protection devices

Surges can enter electronic equipment through the power or through the signal cables (or both). Since it is easy to identify the points of surge entry, the location for the fitting of surge protective devices (SPDs) can also be easily ascertained. The only question is the type of device that should be provided. Metal-oxide varistors (MOVs) are quite adequate for the protection of the mains-connected equipment. However, electronics are characterized by a small difference between the normal circuit operating voltage and the voltage capable of causing damage, and therefore the protection device has to clamp the voltage between the signal lines and the signal reference conductor. For this reason, the sharper knee characteristic of the silicon suppressor is used.

The problem with this type of suppressor is its limited surge energy absorption capability. Additional components are therefore required in the form of a spark-gap device and a series-impedance device. The function of the impedance is to limit the current through the silicon suppressor both before the spark gap has operated (the spark gap does not operate instantaneously owing to inherent delays in the creation of the arc; this delay could be microseconds) and after the spark gap has operated (the arc voltage can be as much as 30 V).

Ideally, the spark gap device should be located at the building entrance where both the cable entry point and the earth bar are situated. The advantages of this position are that the surge currents are diverted as soon as possible and that the large-magnitude magnetic fields associated with the surge current are kept away from the sensitive electronic equipment. For many situations this spark-gap position is not feasible and therefore the closest protective earth is used.

Typically, the mains electrical network should be protected at the first point of entry of the cable by a 40 kA 3-phase and neutral surge protective device (SPD). Any distribution board more than 10 m from the first point of entry should also have the 40 kA SPD for 3-phase and neutral installed or a 40 kA SPD for single phase and neutral. If the distribution boards are less than 10 m from the mains supply, a 6,5 kA SPD for 3-phase or single phase and neutral will be sufficient. The SPD used to protect the electronic equipment will depend on the type of inputs into the equipment, such as telephone lines, antenna cables, or other input types. Lightning and surge protection is a specialized area of expertise and it is recommended that the appropriate individuals or companies (or both) that are proficient in this type of protection be approached for design assistance.

9.3 Power distribution

9.3.1 General

The primary function of the power distribution system is to provide the path for the required power to reach the CCTV equipment. All wires and cables associated with the distribution network have to have the insulation, voltage breakdown and physical characteristics suitable for the voltage, current, power and environment in which they will be used. In addition they have to meet the fire and safety standards of the local authority.

9.3.2 Distribution techniques

When a single item of equipment is connected to the power-supply output, the conductor size, i.e. the wire diameter, has to be sufficiently large so that no significant voltage drop occurs between the power supply and the equipment that could result in too low a voltage being available at the equipment. By specifying the correct conductor size based on the actual distance from the power source to the equipment and the amount of current the equipment requires, the voltage drop will be minimized. It is normal practice to connect equipment in parallel across the power source. If this is the case, it is important to ensure that the equipment at the end of the power line receives the minimum rated voltage for that particular item of equipment.

9.3.3 Safety aspects

Most electronic equipment functions with two generic cable types, namely signal (and control) and power. For safety reasons and to keep extraneous noise from contaminating signals, these two cable types should not run close to each other. In fact the electrical power cables should be run in a separate conduit or trunking from the signal cables. The reason for this is that the power cables are manufactured with insulation resistance sufficient to withstand the higher voltages used in power systems, whereas the signal cables usually have insulation sufficient for voltages up to approximately 100 V. Thus the physical separation of the two types of cable will prevent accidental shorting that could lead to the injury or death of a person handling the signal cable (which could be in dangerous contact with the power cable), or shorting that could lead to sparks and possibly the outbreak of a fire.

9.3.4 Earth loops

Another important aspect of the electrical distribution system is the use of good earthing practices and the elimination or avoidance of earth loops in the system, where earth loops can be considered as the undesirable current paths that connect together earthed points, equipment earth points or signal-return connections. The finite resistance, inductance and capacitance of conductors that carry these earth-loop currents provide a common cross-coupling impedance to inject unwanted signals, noise, and crosstalk into sensitive input circuits.

The optimum configuration can only be determined after a thorough analysis of the distribution system, as well as of the equipment chassis and power-line earthing. Most electronic equipment is so designed that electronic circuitry is earthed at one or more points on the equipment chassis. The system should be so designed that these earth points are connected electrically with a good conductive path from each piece of equipment to the next, and to the earth point of the power distribution grid.

To achieve noise-free CCTV image performance the following practices are recommended:

a) Ensure that proper earthing is in place.

b) Co-axial cables should be terminated at both ends.

c) Equipment chassis and cable shields should never be used for signal-return paths, with the exception of co-axial cables.

d) Signal circuits should use balanced cable, such as twisted pairs or shielded or balanced co-axial lines.

e) Individual shields of balanced co-axial cables, when contained by a common shield, should be insulated from one another and from the common shield.

f) Cables that carry high-level signals should not be bundled with cables that carry low-level signals, whether shielded or not.

g) Each signal cable should have its own independent return line running as close as possible to the signal line, thus reducing the loop area.

h) Use twisted-pair cable (signal and return lines together) to ensure a minimum pickup-loop area.

10 Functional and operating procedures

Functional and operating procedures for the CCTV system should be indexed to facilitate easy reference and include the following:

a) An overview of the complete CCTV system, including an equipment block schematic and a cabling and wiring schematic;

b) The manufacturers' technical specifications for each item of equipment that comprises the CCTV system;

c) The functions and features of each item of equipment;

d) Individual operating instructions for each item of equipment; and

e) Detailed operating instructions for all modes of operation of the CCTV system.

11 Enquiry documentation

It is usual, especially for large CCTV projects, to issue a tender enquiry. This enables contractors who are considered suitable to undertake the required work to bid in a competitive manner for the project in terms of specified performance and functionality requirements as well as price. This enquiry documentation would normally (but not always, as it depends on the size of the CCTV system to be installed) contain the following sections:

a) The invitation to tender: this would contain the invitation, provide a brief description of the works and give the tender return information, such as the return address and the closing time and closing date of the tender;

b) Contract data: e.g. location of the works, client details, contractor's details, important contractual dates;

c) General conditions of contract: the general conditions under which the contract will be executed;

d) Special conditions of contract: these are the special conditions (if any) that apply to a particular project or installation that do not fall within the normal scope of the general conditions;

e) Works information: this will provide a complete description of the work to be performed, i.e. the where, the what and the how, etc.;

f) Technical specification: this would include general technical requirements and equipment or system specifications (or both); more details in respect of this specific aspect are given in clause 12;

g) Bills of quantities: this will provide a list of the items and quantities of equipment required; the tenderers will price against this document; and

h) Other relevant documentation: this could include insurance requirements, performance guarantees, site and equipment layout drawings, and any other information deemed necessary.

12 Technical specifications

12.1 General requirements

The technical specification document should include some or all of the following sections:

a) Regulations under which the installation should be erected and tested;

b) Installation codes of practice that apply;

c) Material, equipment and workmanship conformance standards that apply;

d) Operator training that is required;

e) Maintenance tools and equipment to be supplied as part of the installation;

f) Storage of equipment and materials on site;

g) Co-operation with other trades that might be necessary during the installation process;

h) Supply and control of drawings;

i) Maintenance requirements during guarantee period;

j) Documentation requirements in terms of operating and maintenance manuals; and

k) Any other issue that has to be specified.

12.2 Equipment specifications

NOTE :When drawing up a technical specification, it is recommended that the following minimum equipment Considerations be applied. This list is not exhaustive.

12.2.1 Cameras and lenses

12.2.1.1 General

CCTV cameras should

a) Be of high quality from a reputable supplier,

b) Be of proven reliability and performance,

c) Have a standard video output, and

d) Be compatible with camera control systems, video signal management devices, monitors and video recorders.

Preferably all the cameras should be supplied by one manufacturer to allow for interchangeability if a camera fails. If necessary, colour cameras and monochrome cameras could be supplied by two different manufacturers.

12.2.1.2 Colour cameras

a) High-performance colour cameras suitable for external use should have a horizontal resolution of at least 460 lines.

b) Standard performance colour cameras suitable for internal use should have a horizontal resolutionof at least 330 lines.

12.2.1.3 Monochrome cameras

a) High-performance monochrome cameras suitable for external use should have a horizontal resolution of at least 560 lines.

b) Standard performance monochrome cameras suitable for internal use should have a horizontal resolution of at least 380 lines.

12.2.1.4 Lenses

a) All the lenses should be supplied by one manufacturer, be colour-corrected and have a neutral density filter if required.

b) Any variation in the effective *f*-number of zoom lenses should be declared when the focal length is changed from maximum to minimum.

12.2.1.5 Camera and lens combination

The camera and lens combination should

a) Give the required fields of view when the focal length of the lens is selected in relation to the size of the camera image sensor,

b) Have the correct resolution to reproduce the detail to give the necessary information on the fields of view,

c) Be capable of operating within the range of expected light levels, and

d) Have a lens image area equal to or greater than the area of the imaging device in the camera.

12.2.1.6 Camera and lens housings

The client should specify particular requirements that will influence the choice of the most appropriate camera and lens housings to be installed, such as, for example, the necessity for vandal-resistant housings or the fact that extreme environmental conditions exist in certain areas. This type of specification is particularly important in the case of external cameras and clients should be encouraged to clearly identify additional requirements they deem important. General requirements that apply to all housings, include the following:

a) Access to the camera and lens for maintenance should be simple and require the minimum use of tools while maintaining the security of the housing.

b) The field of view should not be obstructed by the housing.

c) The housing should not degrade the performance of the video camera.

d) The style and aesthetics of the housing should blend in with the installation environment.

e) All power, video and data cables that enter the housing should be protected by flexible conduit.

f) There should be no exposed cable sheaths.

g) The arrangement of the camera and lens mounting has to allow for the separation of the video- signal earth from the housing and local safety earth.

12.2.1.7 External camera and lens housings

12.2.1.7.1 The following are additional requirements that apply to externally mounted equipment:

a) External camera and lens assemblies should be securely mounted in a weatherproof enclosure.

b) The housing should be of a rugged construction, resistant to corrosion and generally vandal-resistant.

c) The aperture window should be of toughened glass.

d) The housing should be fitted with a sun visor.

e) All cables and conduit should be secured to the housing by using suitably sized weatherproof glands.

12.2.1.7.2 Optional requirements that could apply, depending on environmental conditions or location, are, for example

a) The fitting of a self-parking wiper, and

b) The fitting of a thermostatically controlled heater inside the housing.

12.2.2 Pan-and-tilt units

12.2.2.1 General

The pan-and-tilt heads should be selected to support the weight of the camera, lens, housing and any additional equipment and operate satisfactorily when subject to unbalanced platform loading and wind loading. In addition the following should also apply:

a) The use of extra-low voltage mechanisms is recommended, from a safety point of view.

b) The unit should be reliable and require minimum maintenance.

c) The available pan angle of rotation should be not less than 360°.

d) The tilt mechanism should enable a minimum variation of between 60° and 90° from the horizontal (or as specified elsewhere).

e) The backlash on pan-and-tilt movement should be less than 0.5°.

f) Adjustable mechanical limit stops should be provided to restrict rotation where necessary.

12.2.2.2 Fixed-speed unit

Fixed-speed pan-and-tilt units should have

a) A pan speed of not less than 6° per second, and

b) A tilt speed of not less than 3° per second.

12.2.2.3 Variable-speed unit

Variable-speed pan-and-tilt units should have

a) A minimum range of pan speed of 0,5° per second to 24° per second, and

b) A minimum range of tilt speed of 0,5° degrees per second to 15° per second.

12.2.2.4 External applications

External pan-and-tilt units should be of a rugged construction designed for medium-duty operation. The client should also note that planning permission might be required for the installation of this type of equipment in certain locations.

12.2.2.5 Brackets and towers

Brackets and towers should

a) Be designed to take into account the maximum supported load and the height at which equipment is required to operate,

b) Be installed in accordance with the manufacturer's instructions,

c) Be installed such that access and maintenance (including the replacement of cameras and pan-and- tilt heads) is not restricted, and

d) Take into account the local environmental conditions, including lightning protection.

12.2.2.6 Towers

Camera towers should

a) Be rigid enough to minimize deflection of the camera during high winds; the movement should take into account the height of the tower, the weight of the equipment and the potential adverse effect on camera performance,

b) Be protected against environmental degradation, and

c) be telescopic or hinge down for access purposes, where possible.

12.2.2.7 Performance specification

12.2.2.7.1 From the control point, the operator should, for each and every camera (where relevant),be able to

a) Operate the pan and tilt,

b) Control the pan movement of the camera throughout the complete range,

c) Control the tilt movement of the camera throughout the complete range,

d) Control the operation of the zoom lens over the complete range,

e) Operate the screen wash / wipe facility,

f) Operate any auxiliary lighting associated with the camera,

g) Operate any other equipment or functions as specified,

h) Select the order of the cameras and the time allowed for each camera view, and

i) Set up a program to sequentially switch the required number of cameras.

12.2.2.7.2 Optional features of the camera controller that should be specified separately include

a) An autopan feature to allow for the automatic operation of PTZ cameras,

b) Provision of continuous movement of the camera with adjustable pan speed,

c) provision of random movement of cameras between various preset positions, program positions, dwell time at each position and speed of movement between each position, and

d) An alarm override feature.

The speed of response of the pan, tilt and zoom features should be within 0.1 s of the operator's actuating the controls.

12.2.2.8 Hardware specification

12.2.2.8.1 The control equipment should

a) Have standard video signal inputs and outputs, and

b) Be compatible with cameras, monitors, video recorders and video signalling management devices.

12.2.2.8.2 The control panel should

a) Have clear legible characters,

b) Be robust,

c) Be simple to operate, and

d) Have joystick control when variable-speed pan-and-tilt control is available; the movement of the joystick should be weighted to control the speed.

12.2.3 Monitors

12.2.3.1 General

Monitors should

a) Be metal-cased, unless otherwise specified,

b) Have standard video signal inputs and outputs,

c) Be compatible with cameras, control equipment and video signal management devices, and

d) Have switchable input impedance: 75 Ω / high impedance.

The client should specify the optional features of the camera controller separately.

12.2.3.2 Colour monitors

For high-resolution colour CCTV systems the following monitors should be used in conjunction with high-resolution (460 line) colour CCD cameras:

a) 14 inch or 15 inch colour monitors, which should have a picture quality of greater than or equal to 450 lines horizontal resolution; and

b) 21 inch colour monitors, which should have a picture quality of greater than or equal to 400 lines horizontal resolution.

Colour monitors should have accessible controls for colour, contrast, brightness, horizontal hold and vertical hold. Medium resolution colour monitors should have a resolution of 250 lines to 350 lines, depending on the size of the monitor.

12.2.3.3 Monochrome monitors

Monochrome monitors should have accessible controls for contrast, brightness, horizontal hold and vertical hold. Standard monochrome monitors (sizes 5 inch to 20 inch) should have a minimum resolution of 600 lines.

12.2.4 Video signal management system

12.2.4.1 General

A CCTV video signal management system should

a) Have the facility to display a video signal from any camera on any monitor within a specified group, and

b) Display the identification number of each monitor on the screen and on any recorded video signal.

12.2.4.2 Video switchers

Video switchers should

a) Be used to manually or automatically switch a number of video input signals to one or more outputs,

b) Operate with no loss in picture quality or signal strength,

c) Have standard video signal inputs and outputs,

d) Display descriptive text on real-time pictures and recorded pictures,

e) Have sequential camera output, and

f) Provide a manual option to select single camera output and to have adjustable camera dwell time during sequencing.

12.2.4.3 Quad screen splitter

12.2.4.3.1 Quad screen splitters should have the following specification:

a) Power supply: 240 V 50 Hz;
b) Four standard video signal inputs;

c) Two standard video signal outputs (monitor and VCR) and four loop-through video outputs; and

d) Four alarm inputs.

12.2.4.3.2 The quad splitter should have the following functions:

a) Menu-driven set-up program;

b) Full-screen display of selected picture;

c) Automatic full-screen sequential switching;

d) Real-time display;

e) Alarm signal to enable relevant camera on full screen and trigger VCR operation;

f) At least a six-character description of each camera picture;

g) Freeze frame; and

h) VCR facility.

12.2.4.4 Multiplexers

12.2.4.4.1 The following should be specified for a multiplexer:

a) Colour, or colour and monochrome, or monochrome cameras and monitors;

b) Record only (simplex) or record and simultaneous display (duplex); and

c) Number of inputs (cameras) (Multiplexer units can be designed for 4,8,9,10,16,24,32 or more cameras; the installer should define the number of inputs in the quotation.).

12.2.4.4.2 Multiplexers should have the following functions:

a) Power supply 240 V 50 Hz;

b) loop-through inputs;

c) Number of outputs;

d) Simultaneous recording of all inputs;

e) Real-time display on time switcher output;

f) Record or real-time / multiscreen display on monitor;

g) Alarm input to provide real-time record on alarm cameras;

h) Alarm input to trigger real-time recording of relevant camera;

i)alarm indication during recording and playback;

j) Text description available for each camera and recorded onto tape;

k)Date and time generation displayed on monitors and recorded pictures;

l) date and time synchronized between all multiplexers and VCRs;

m) Sequential display of all cameras;

n) Manual override to select single view;

o) On-screen menu;

p) Freeze frame on playback; and

q) Time-lapse adjustment.

All multiplexers should be from the same manufacturer to ensure full interchangeability.

12.2.5 Picture storage/retrieval system

12.2.5.1 Video recorders: minimum specification

Video recorders should meet the following minimum specification:

a) 625 lines CCIR European PAL colour system;

b) Standard video signal inputs and outputs;

c) Tape format: VHS 1-inch-wide high-density video tape;

d) Maximum cassette size: 3 h (E180);

e) Maximum rewind time (E180): 4,5 min;

f) Tape speed: 23,39 mm/s (3 h mode);

g) horizontal resolution: > 240 lines VHS colour;
> 320 lines VHS monochrome;

h) Video signal-to-noise ratio > 45 dB; and

i) Compatibility with cameras, monitors, and video signal management devices.

12.2.5.2 Video recorder: standard functions

12.2.5.2.1 The VCR should have the following standard functions:

a) loop-through video;

b) 3 h, 12 h or 24 h continuous-mode recording (48 h, 72 h, 168 h or 720 h are available if a weekend, week or month has to be covered);

c) Alarm recording;

d) Fully automatic head cleaning;

e) end-of-tape alarm;

f) noise-free still frame;

g) Frame advance;

h) Speed search / slow motion playback; and

i) Tape recorded in standard 3 h mode can be replayed on any VHS recorder.

12.2.5.2.2 Video recorders should

a) Be of the same manufacture and interchangeable,

b) Be fully compatible with the multiplexers for operation in time-lapse recording and playback modes,

c) Be switchable between linear and step functions when used in playback mode,

d) Have the facility to change the mode of the recorders to either 3 h mode, 12 h mode or 24 h mode,

e) Allow continuous time-lapse recording of all specified cameras,

f) Allow real-time recording and playback to occur in 3 h mode, and

g) Have a minimum start-up time or response from time-lapse mode to normal mode (if a time-lapse recorder is used).

12.2.5.3 Video printers: common features

Colour and monochrome video printers should have the following common features:

a) 625-line CCIR European PAL system;

b) Standard video signal inputs and outputs; and

c) Compatibility with cameras, monitors, recorders and video signal management devices.

12.2.5.4 Colour video printers

Colour video printers should provide the following:

a) Print size: minimum 150 x 100 mm;

b) Picture size: minimum 100 x 75 mm;

c) Picture resolution: 600 dots horizontal (min. 100 mm) x 500 dots vertical (min. 75 mm); and

d) Print gradation : 256 levels process.

Colour video printers should have the following features:

a) Instant response;

b) High resolution; and

c) Sequential printing.

12.2.5.5 Monochrome video printers

Monochrome video printers should provide the following:

a) Picture size: minimum 90 x 68 mm;

b) Picture resolution: minimum 800 (min. 90 mm) x 500 (min. 68 mm) dots; and

c) Gradations: 256 grey levels (quasi).

12.2.5.6 Infrared and laser transmission

Infrared and laser transmission equipment shall

a) Be firmly mounted to avoid movement and misalignment,

b) Comply with health and safety requirements, and

c) Take into account the effects of poor weather conditions and vegetation that can reduce signal strength.

12.2.5.7 Optical fibre

Optical fibre transmission systems shall

a) Utilize commonly available types of cable and appropriate types of connector, and

b) Be designed to accommodate at least three repairs in the cable during its lifetime.

13 System test specification

Before the CCTV system is handed over to the end user, it should be thoroughly checked electrically, mechanically and visually to ensure that it complies with the technical specification. This checking of the system should comprise the following:

a) All parts of the CCTV system should be checked visually and functionally. The basis for the functional check should be the system test specification as developed from the operational requirement and the technical specification.

b) The visual test should cover the quality of workmanship of the installation, the functional quality of the equipment and their compliance with the technical specification.

c) The functional test should include checking the functional compatibility of the components of the system.

In large systems it is recommended that inspections be carried out at regular intervals during the installation of the system. Practical testing and commissioning should be carried out by CCTV personnel other than those employed on the installation of the equipment or system (or both). Commissioning personnel should carry out the tests detailed in the acceptance test procedures.

14 System maintenance requirements

The CCTV system should be maintained periodically in accordance with the equipment manufacturers' recommendations and any specific requirements of the client. It is recommended that the CCTV contractor provide a maintenance plan that details the tests to be undertaken, a recommended list and quantities of spares to be held, the service periods, and special test instruments and tools required. This information will form part of any maintenance agreement to be concluded between the end user and the contractor.

It is further recommended that an identification procedure be established for the CCTV contractor's maintenance personnel, and that the end user's representative be notified before the start of a maintenance inspection. It might also be necessary for parts of the CCTV system to be inspected outside normal working hours; this should be clearly stated in the maintenance agreement.

Should a problem occur outside the normal maintenance inspection visit, it is essential that the end user be kept informed of the contractor's emergency service facilities, such as names, addresses and telephone numbers (or contact details) of service personnel.

Annex A

(Informative)

Layout schematic of a typical large CCTV surveillance system

The basic items required for any simple CCTV system are a camera, a lens, a transmission link, and a monitor. As the system becomes more comprehensive, additional items are provided, such as video switchers or multiplexers, recorders, hard-copy printers and other ancillary equipment (for example, pan-and-tilt mechanisms, housings, text generators, etc.). The following diagram illustrates a typical large CCTV system that uses some of these items of equipment.

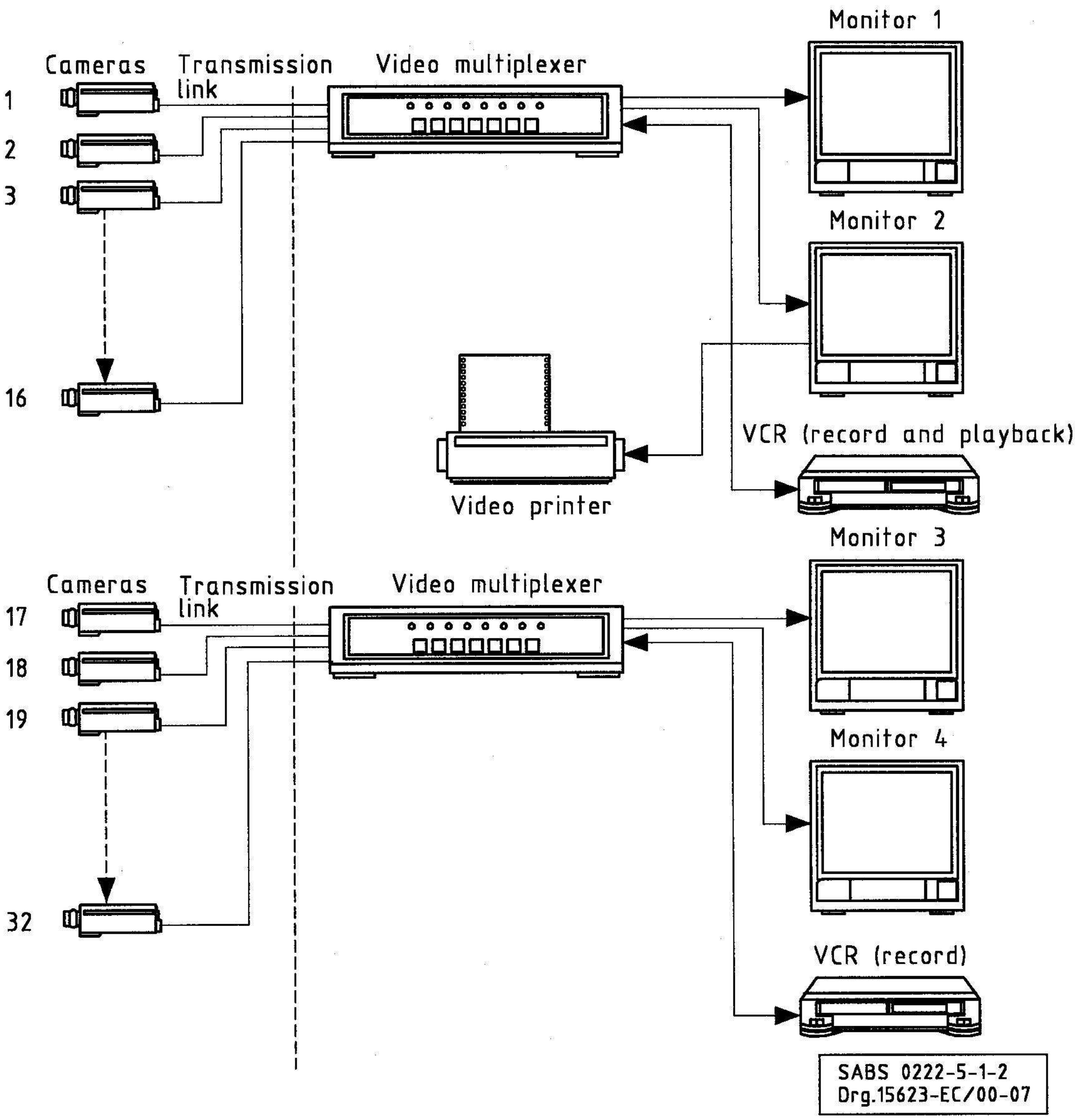

Figure A.1 – Typical large CCTV system

Annex B
(Informative)

Typical CCTV system that uses a matrix switcher

Matrix switchers are based on microprocessor principles that allow a tremendous potential of flexibility in routing and processing signals. The pre-programming and automating of camera pan or tilt (or both), preset camera pointing and automatic switching functions are combined in one control unit. These switchers range from small compact units that control 16 or 32 cameras, several monitors and keyboards to large modular systems that control, say, 1 028 cameras and 99 monitors. The following diagram shows a typical CCTV system and equipment layout that uses a matrix switching unit.

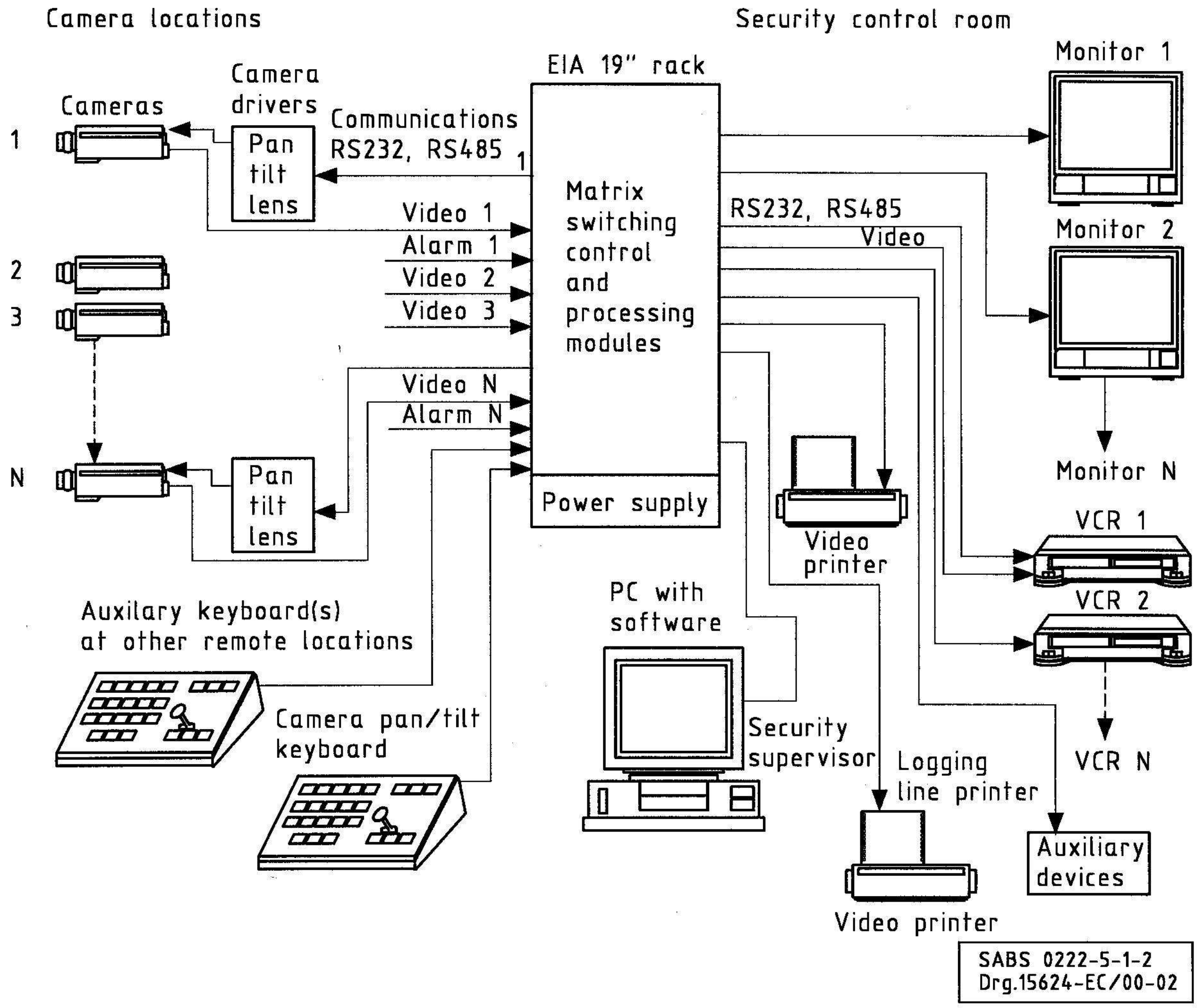

Figure B.1 – CCTV system that uses a matrix switching unit

Annex C

(Informative)

Index of protection ratings

The protection is defined by two digits prefixed by the letters IP, or index of protection. The first digit indicates the degree of protection that is provided with respect to the equipment inside the enclosure, and the second digit indicates the protection that is provided with respect to the harmful ingress of water. In some countries a third digit is sometimes added (although not too common), which indicates the degree of mechanical protection. The following table lists the various degrees of protection in terms of the two-digit system only.

IP RATINGS			
1ST IP Degree of protection\digit	**Definition**	**1ST IP Degree of protection\digit**	**Definition**
0 Zero protection	No special protection	0 Zero protection	No special protection
1 Protection against solids greater than 50 mm	Large surface of human body such as hand, none against deliberate access	1 Protection against dripping water	Vertically falling dripping water should have no harmful effect
2 Protection against solids greater than 12 mm	Fingers or similar objects no exceeding 80mm in length	2 Protection against dripping when tilted up to 15^{0}	Vertically falling dripping water shall have no harmful effect when the enclosure is tilted at any angle up to 15^{0} from its normal position
3 Protection against solids greater than 2.5 mm	Tools/wires of thickness or diameter greater than 1.0 mm	3 Protection against water spray	Water falling as a spray at an angle of up to 60^{0} from the vertical shall have no harmful effect.
4 Protection against solids greater than 1.0 mm	Wires or strips greater than 1.0 mm	4 Protection against splashing water	Water splashed against the enclosure from any angle shall have no harmful effect.
5 Dust- protected	Total protection against dust is not provided but sufficient protection to allow satisfactory operation	5 Protection against splashing water	Water projected by a nozzle against the enclosure from any angle shall have no harmful effect.
6 Dust- tight	No ingress of dust	6 Protection against heavy seas	Water from heavy seas or water projected by powerful jets shall not enter the enclosure in harmful quantities
		7 Protection against the effects of submersion	Ingress of water in a harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of time and pressure
		8 Protection against the effect of continuous submersion	Suitable for continuous submersion in water under conditions specified by the manufacturer.

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Annex D

(Informative)

Typical video transmission methods

In its most common form, the CCTV video signal is transmitted at baseband frequencies over a coaxial cable. However, it is often a requirement that video signals be transmitted from a camera site to a remote location. The following diagram illustrates the various video transmission methods available. The actual choice of transmission medium will be dictated by circumstances associated with the camera and control point location. Often there will be more than one option of transmission method and it will often come down to a trade off between quality and security of the video signal and the cost involved.

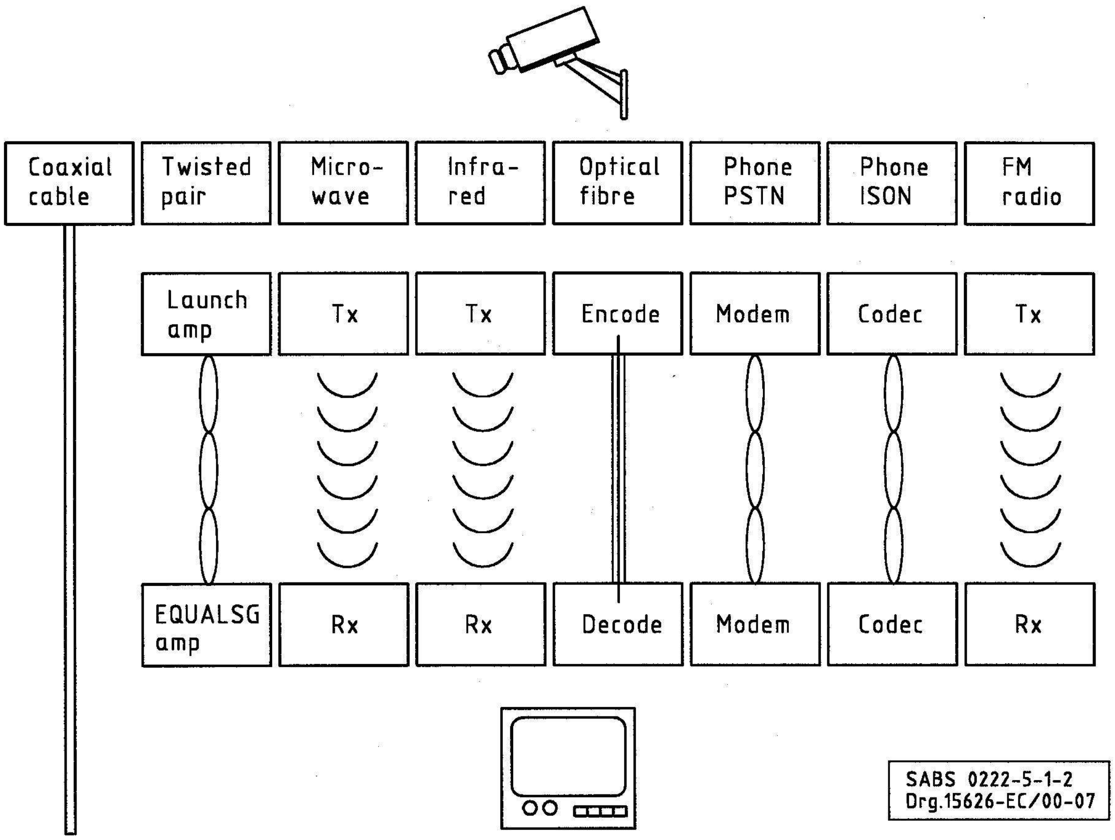

Figure D.1 – Typical video transmission methods